The impact of labor market conditions on job creation: evidence from firm level data.

Job Market Paper

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Abstract

Changes in labor market conditions make hiring more expensive during expansions and cheaper during recessions, creating counter-cyclical incentives for job creation. In this paper, I study how much changes in labor market conditions reduce employment fluctuations over the business cycle. First, I estimate firm level elasticities of labor demand with respect to changes in labor market conditions, allowing for heterogeneous response both across firms and across regions. I consider two margins: changes in labor market tightness and changes in wages. Using the employer-employee matched data from Brazil, I find that all firms are more sensitive to changes in wages rather than labor market tightness, and there is substantial heterogeneity in labor demand elasticity across regions. Next, I demonstrate that changes in labor market conditions reduce the variance of employment growth over the business cycle by 20% in a median region, and this effect is equally driven by changes along each margin. Moreover, I show that the magnitude of the effect of labor market conditions on employment growth can be significantly affected by economic policy. In particular, I document that the rapid growth of the national minimum wages in Brazil in 1997-2010 amplified the impact of the change in labor market conditions during local expansions and diminished this impact during local recessions.

JEL Classification: J23, E23, J64

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1 Introduction

Changes in labor market conditions make hiring more expensive during expansions and cheaper during recessions. During expansions, consumer demand and productivity grow, but job creation becomes increasingly more costly, as firms face tighter labor markets and have to pay higher wages to attract new workers. For instance, during the latest expansion of the US economy, the ratio of job seekers to vacancies decreased from 2.7 in 2003 to 1.4 in 2007 (Klemmer, 2010), while the average wage rose by 11% (BLS, 2015). The opposite change in labor market conditions occurs during recessions: unemployment spikes, and wage growth slows down. Thus, changes in labor market conditions over the business cycle create counter-cyclical incentives for hiring. Do firms respond to these incentives? If the answer is positive, the cyclical fluctuations of labor market conditions have a potential of stabilizing employment growth over the business cycle, stimulating the economy during recessions and preventing it from overheating during expansions.

However, to predict the magnitude of this effect it is critical to understand the mechanism through which it propagates. In particular, one needs to know which margin has a bigger impact on job creation: changes in wages or changes in labor market tightness. For instance, at the peak of the Great Recession the ratio of job seekers to vacancies was as high as 6.2, but average wage kept growing at its pre-recession pace. As a result, the stimulus from the reduction in labor market tightness was partially offset by the lack of adjustment in wages. Thus, the size of the net effect depends on the relative importance of each margin. Distinguishing between the two margins can also inform economic policy. For instance, if wage changes contribute to job creation more than changes in labor market tightness, extending unemployment benefits or raising minimum wage during recoveries can be detrimental to employment growth. Having a sound understanding of which firms are affected by such changes and being able to evaluate the size of the net effect can help to design targeted policy to stimulate employment growth.[1]

Though the effect of labor market conditions on job creation lies at the heart of the role of labor markets in business cycle propagation, it has not been studied directly. In particular, the macro literature has extensively studied the volatility of vacancies and unemployment over the business cycle (Shimer, 2005; Hagedorn and Manovskii, 2008), but has essentially taken as given the following response of demand for labor to slacker labor markets. On the other hand, the micro literature has concentrated on migratory (Yagan, 2014) and wage (Davis and von Wachter, 2011) consequences of recessions and has abstracted from the labor demand adjustment. Finally, several recent studies have documented differential employment growth across firms at times of low and high unemployment (Moscarini and Postel-Vinay, 2012; Kahn and McEntarfer, 2014; Fort et al., 2013), but have not specifically analyzed the effect of labor market conditions on job creation.

In this paper, I investigate how much changes in labor market conditions reduce employment fluctuations over the business cycle. First, I build a search and bargaining model of local labor

[1] One example of such policy was the HIRE Act of 2010, which introduced tax breaks for small businesses that hired previously unemployed workers.

markets with heterogeneous firms and estimate labor demand elasticities at the firm level using employer-employee matched data from Brazil. Unlike the previous studies (Moscarini and Postel-Vinay, 2012; Kahn and McEntarfer, 2014; Fort et al., 2013), which focus only on the changes in unemployment, I consider two margins of adjustment: changes in wage and changes in labor market tightness. In addition, I allow labor demand elasticities to vary across local labor markets, which enables me to analyze employment fluctuations across regions. Informed with these estimates, I study the contribution of labor market conditions to employment growth at the regional level. I estimate how different employment growth would have been if labor market conditions did not change over the business cycle, but regional economies experienced the same changes in consumer demand and productivity.

The key mechanism which I study stems from the idea that an increase in demand for labor in one industry has a general equilibrium effect on firms in other industries who hire workers on the same labor market. This mechanism propagates through two channels: change in labor market tightness and change in wages. If one industry is expanding, it tightens the labor market by reducing the total number of workers available for hire. Similarly, if one industry starts paying higher wages, other industries have to match this increase to be able to attract workers. This general equilibrium mechanism was first clearly formulated in Beaudry et al. (2012), who have shown that an expansion of a high paying industry in a city leads to an overall wage increase in that city. Beaudry, Green, and Sand have used this framework to estimate the long-term elasticity of labor demand in Beaudry et al. (2014). In this paper, I apply their idea to the employment fluctuations over the local business cycles. My paper innovates on Beaudry et al. (2012) and Beaudry et al. (2014) in three ways. First, I introduce heterogeneous firms into their theoretical framework and allow for heterogeneous sensitivity to labor market conditions across regions. Second, Beaudry et al. (2014) have studied the long-term (decennial) labor demand elasticities, and I focus on the effect of labor market conditions on employment growth over the business cycle. And finally, I estimate labor demand elasticity at the firm level, rather than at the regional level.

I perform the analysis using employer-employee matched data from Brazil in 1997-2010. The richness of the data allows me to construct reliable series of wage changes, which are usually unavailable in the aggregate data. I control for worker characteristics (age, eduction and gender), job characteristics (occupation and tenure of the job), and firm characteristics (firm age and the status of a multi-establishment firm) and calculate real wage series for a fixed demographics group. This procedure ensures that none of the results are driven by changes in the composition of the workforce over the business cycle.

The fundamental challenge in estimating labor demand elasticity lies in separating the changes in labor market conditions from the changes in firm's productivity. This identification problem is analogous to distinguishing the movement along the demand curve from the shift of the demand curve itself in a standard demand estimation. Indeed, a more productive firm will be able to pay higher wages to its workers, but the resulting wage growth will not be caused by the changes in labor market conditions. Likewise, an increase in productivity of a large firm can lead to a substantial number of additional hires and affect the labor market tightness for the whole region.

In order to isolate the movements of labor market conditions, I rely on two types of instruments. First, I build on the idea of Beaudry et al. (2014) that the labor demand shocks to other firms in the same location can be used as a supply shock to the firm under consideration and utilize a Bartik shock, a common instrument for labor demand[2], as a source of exogenous variation in labor market tightness. A Bartik shock in employment measures how big employment growth in each region would have been if each industry expanded at the national rate of growth in that industry. Thus, a Bartik shock is a predictor of overall employment growth at the regional level.[3]

I instrument for the change in wages at the firm level in a similar manner by calculating predicted rate of wage growth in each region using the national trends in each industry. Since each firm in the region would have to match this wage increase to be able to attract workers, the wage increase at the firm level due to the overall wage increase would capture the effect of the change in labor market conditions rather than an increase in the revenue of that firm. Second, I explore the fact that Brazil has a federally mandated minimum wage, which is set discretionarily and changes approximately once a year.[4] For each firm, I calculate the share of workers in the previous year which did not meet this year minimum wage threshold and use this measure as a wage shock to the firm.

However, this identification strategy is invalid if the demand shocks are correlated across industries. The minimum wage and Bartik instruments are orthogonal to local- and firm-specific demand shocks, but still both contain nationwide industry shocks. To resolve this concern, in my estimation equation I control for nationwide industry shocks explicitly, using the nationwide average wage growth in each industry as a proxy for a demand shock in that industry. In addition, I restrict the analysis to manufacturing firms, which allows me to assume that the demand for goods in the economy is exogenous to the local industrial composition and abstract from the effect of local multipliers.

I estimate the model using General Method of Moments (GMM), allowing the elasticities of the labor demand to depend on the wage a firm is paying. I find that a one standard deviation increase in labor market tightness reduces employment growth by 1.7 percentage points, while a one standard deviation increase in wages reduces employment growth by 3.1 percentage points in a median firm in a median region. Furthermore, there is substantial heterogeneity in response to changes in labor market conditions across regions.

I use these estimates to analyze the contribution of changes in labor market conditions to regional employment growth. I consider a scenario in which any change in the demand for labor is exactly offset by migration, so that the labor market tightness remains the same, and neither an

[2] See, for example, Bartik (1991); Blanchard and Katz (1992); Bound and Holzer (2000); Notowidigdo (2013); Diamond (2012).

[3] Following the common practice, I exclude employment growth in each region from the national trend calculation and use the lagged industrial composition in each region to construct the predicted regional growth. This procedure ensures that a Bartik shock is not contaminated with the local trends or changes in firm's own productivity.

[4] Each state can impose its own minimum wage, but it cannot be lower than the federal minimum.

increase in worker's outside options nor the growth of firm's revenue translate into higher wages, keeping the wage level in each firm constant. I show that compared to this scenario, a median region experienced a 20% reduction in the variance of employment growth over the business cycle due to changes in labor market conditions. I argue that this effect is equally caused by changes in labor market tightness and changes in wages. Moreover, I argue that the rapid growth of the national minimum wages in Brazil in 1997-2010 generated heterogeneous effects of labor market conditions on employment growth across regions. In particular, I document that microregions with higher exposure to minimum wage increase experienced smaller stabilizing effect of the change in labor market conditions during local recessions and larger diminishing effect of the change in labor market conditions during local expansions.

My results suggest that labor market conditions can have a substantial impact on employment growth over the business cycle. However, my analysis faces two limitations. First, I focus on the intensive margin and do not take into account changes in the regional employment growth due to entry of the new firms. Next, because I use the data on manufacturing firms in the formal sector, my results should be interpreted as the impact of labor market conditions on fluctuations in the formal employment in the tradable sector. For instance, if the increase in the competition for workers pushes more firms to hire workers informally, my results would capture this effect but suggest that employment is growing slower. Thus, I will not be able to distinguish between the slow down in the overall employment growth and the increase in the incidence of informality.

My paper connects several strands of literature. I revisit the widely studied question of regional response to shocks, first extensively covered in Blanchard and Katz (1992). However, unlike the many studies in this literature, who investigated the migratory response to shocks (see, for instance, Notowidigdo, 2013; Yagan, 2014), I analyze the labor market adjustment of the demand side of the market. To my knowledge, I am the first paper to estimate the labor demand response to changing labor market conditions over the business cycle.

I also contribute to a large body of literature which uses a local labor market approach to study the effect of shocks (Autor et al., 2013; Dix-Carneiro and Kovak, 2015; Topalova, 2007; Beaudry et al., 2012). This approach allows me to exploit differential exposure to nationwide shocks across regions and provides a clear identification strategy of the effect of labor market conditions on employment growth.

Next, my paper provides new evidence on differential sensitivity to labor market conditions across firms. Though the findings in this literature suggest differential cyclicality of employment growth across low- and high-paying firms in the US (Moscarini and Postel-Vinay, 2012; Kahn and McEntarfer, 2014; Fort et al., 2013), existing studies provide descriptive evidence rather than estimate the causal relationship. To my knowledge, this is the first paper to estimate firm level elasticity of labor demand with respect to changes in labor market conditions. In addition, I am the first paper to discover heterogeneous response to labor market conditions across regions.

Finally, my paper is close in spirit to the studies which aim to match firm level dynamics to the stylized facts on aggregate fluctuations (Cooper et al., 2007; Elsby and Michaels, 2013).

These papers focus on modeling decisions of firms to generate observed aggregate volatility of employment and wages in response to revenue shocks. I take this response as given instead and estimate the magnitude of general equilibrium adjustment to the resulting changes in labor market conditions.

The rest of the paper is structured as follows. I start by describing the basic facts on the changes of labor market conditions over the business cycle in section 2. Then I develop a model of local labor markets with heterogeneous firms and derive the firm-specific response to a change in local labor market conditions in section 3. After that, I explain the identification strategy in section 4. I take the model to the data and present results on the magnitude of labor demand elasticity in section 5. Then I discuss the impact of labor market conditions on employment growth at the regional level in section 6. Finally, I summarize the findings and suggest the steps for future research in section 7.

2 Variation in Labor Market Conditions

I start my analysis by establishing the key facts on the changes in labor market conditions over the business cycle. First, I briefly describe the data and introduce the definition of a local labor market. Then, I explain how I measure labor market conditions. Finally, I document the key stylized facts. I show that:

1. Though both labor market tightness and wages co-move across regions, there is substantial variation in labor market conditions across regions in any given year.

2. Labor market tightness responds strongly to local business cycle.

3. Prevailing wages responds to local business cycle as well. However, in microregions which are more exposed to increase in national minimum wage, wages are growing more independently of local business cycles.

2.1 Data and definition of a local labor market

I study the impact of labor market conditions on job creation using *Relação Anual de Informações Sociais (RAIS)* — an employer-employee matched dataset from Brazil, collected annually by the Brazilian Ministry of Labor. It covers all formal sector jobs in Brazil and contains detailed information on workers, including their monthly salary, contract hours, tenure on the job, occupation, level of education, age, and gender, as well as establishment identifier, which allow me to track firms over time. These data possess several desirable features. First, since RAIS contains such a detailed information about the workers, it allows me to adjust wage series for the changes in workforce composition in a very accurate way. Adjusting for such a rich set of workers characteristics is not possible, for instance, in the Longitudinal Employer-Household Dynamics (LEHD), employer-employee linked dataset in the US, because it lacks information on occupations. Next, RAIS provides the data at the firm level, which allows me to study firms' contribution to employment fluctuations at the regional level without contaminating the results with the reclassification bias, a concern in the aggregate data which creates mechanical correlation between firm's size and firm employment growth (Moscarini and Postel-Vinay, 2012). Finally, Brazil is a large country with significant heterogeneity across regions. It doe not have a single region which encompasses most of the economic activity or has a particularly high concentration of the labor force, and it has a diversified economy.

I study microregions – statistical units which combine several municipalities – as isolated local labor markets. Microregions cover the whole territory of Brazil and are a commonly used definition of a local labor market in the context of Brazil (See, for example, Kovak, 2013; Dix-Carneiro and Kovak, 2015). A microregion is defined by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*, IBGE) as a region which encompass local production, distribution, exchange and consumption. The geographical borders of microregions were revised several times during the period of observation, so I use the minimally geographically consistent definitions of microregions, which result in 486 microregions in total. However, because some microregions have very small presence of manufacturing, I restrict my analysis to the microregions which had at least 20 firms in manufacturing in each year for at least 10 years of the data. This restriction leaves me with 331 microregions (see figure 1 for a map). According to 2000 Census, an average microregion in the sample contained 450,000 people in 2000, had 13% of employment in manufacturing, out of which 51% was employed in the formal sector, and had 370 manufacturing firms with more than 5 employees in RAIS (table 6).

I analyze the period of 1997–2010, which gives me 14 years of data. Over these years Brazil's GDP per capita grew on average 1.75% annually with three major episodes of slowdown: in 1998/1999 due to the Asian crisis, in 2001/2002 due to political uncertainty over the upcoming presidential election and in 2008/2009 as a consequence of the global financial crisis. I restrict my analysis to the manufacturing sector only, which allows me to treat the goods which firms produce as tradable, which is essential for identification. I discuss this requirement at length in section 4. Employment growth in manufacturing generally tracked the national growth pattern, but grew at lower rates than the national GDP per capita (figure 2). However, in each year the spread in employment growth across regions remained quite big – the interquartile range never went below 7 percentage points, with a maximum of 15 percentage points in 1997.

2.2 Measuring local labor market conditions

Labor market conditions are characterized by two margins: labor market tightness and prevailing wages. Labor market tightness, defined as a trio of vacancies over unemployed, determines how easy it is for a firm to find a new worker, and prevailing wages shows how much a firm has to pay to make a hire.

Labor market tightness. Traditionally, labor market tightness is measured either by the ratio of vacancies to unemployed, or by the unemployment level. Since RAIS does not report vacancies, and the data on unemployment is not available at the microregion level at the annual frequency, I construct two alternative measures of labor market tightness.

The first alternative measure of labor market tightness is the employment to population, which is closely linked to vacancies over unemployment ratio through through the matching function. Assuming that the matching function takes a standard Cobb-Douglas form, the vacancy filling rate, denoted by ϕ, is determined by the labor market tightness:

$$\phi = \left(\frac{V}{U}\right)^{-(1-\sigma)}, \tag{2.1}$$

where V denotes vacancies, U denotes unemployed, and σ is the parameter of the matching function. Next, in the steady-state equilibrium the number of jobs in the economy remains stable if the number of hires equals to the number of separations. Denoting the separation rate by δ, and denoting the number of jobs by E, this equilibrium condition writes as follows:

$$\phi V = \delta E. \tag{2.2}$$

Using these two equations, and assuming that parameters of the matching function do not change over time, the ratio of vacancies to unemployed can be expressed as a function of employment to population ratio, denoted by $\frac{E}{L}$:

$$\log\left(\frac{V}{U}\right) = \frac{1}{\sigma}\log\delta + \frac{1}{\sigma}\log\left(\frac{E}{L}\right) - \frac{1}{\sigma}\log\left(1-\frac{E}{L}\right). \tag{2.3}$$

Guided by this representation, I use annual percentage changes in the ratio of formal employment to population to measure the changes in labor market tightness. This measure has several important features. First, when the ratio of formal employment to population increases, the labor market becomes tighter, and thus it is harder for firms to hire workers. Second, because this measure relies on the aggregate data, it is available for all microregions in all periods. Third, this measure takes into account changes in labor market tightness due to migration, because it is based on the actual number of jobs, which might be taken by migrant workers as well, and population estimates, which take into account migrants.

However, this measure does not include jobs in the informal sector. Thus, if employment growth in the informal sector is positively correlated with employment growth in the formal sector, I will be overestimating the changes in labor market tightness. To understand how important this issue is, I regress employment growth in the informal sector, employment growth among self-employed, total employment growth and the change in unemployment rate on the employment growth in the formal sector at the state level using the data from PNAD – an annual nationally representative in Brazil survey similar to CPS. Table 1 demonstrates that employment growth in the formal sector in not correlated with employment growth in the informal sector or among self-employed, but is a strong predictor of the total employment growth and os associated with a decline in unemployment rate. Therefore, change in the formal employment to population ratio is not contaminated by positive (or negative) correlation with the growth in the informal sector.

The second alternative measure of labor market tightness is the probability for a worker who separated from a job to find a new job. In tighter markets, it is harder for firms to fill a vacancy, but easier for workers to find a job. Thus, the job arrival rate ψ is informative about the labor market tightness, and can be expressed as:

$$\psi = \left(\frac{V}{U}\right)^{-\frac{\sigma}{1-\sigma}}. \tag{2.4}$$

To measure the changes in job arrival rate in each microregion, I calculate changes in probability to find a job iin the current year. Using RAIS, I track new hires among all workers who separated from a formal sector job either in the current or in the past year in each microregion. Then, I exclude those workers who have found a job in the past year and calculate a probability to find a job by the end of the current year for the remaining workers.

One of the concerns with this procedure is that I do not observe hires into the informal sector and thus would underestimate the job arrival rate in manufacturing, if the share of workers who switch from formal to informal sector is high. According to PNAD, 25% of newly hired workers by the informal sector within each year have had their previous job in the formal sector. To minimize this concern, I use only workers who have left a formal sector in the current or previous year, as the share of workers taking a job in the informal sector will be higher for longer spells outside of the formal sector.

The two measures of labor market tightness are highly correlated (figure 3), but the change in probability to be hired has higher variance, which is likely to be due to measurement error. Thus, my preferred measure of labor market tightness is the ratio of the formal employment to population ratio, and I also perform robustness estimation using the change in probability to be hired.

Prevailing wages. RAIS contains detailed information on firms and workers, which allows me to construct wage series at the firm level, adjusted for differences in workforce composition across firms. Analyzing wages at the firm level rather than at the microregion level is essential because there is substantial variation in wage changes across firms within the same industry and microregion, even though in general wages move together across different firms and microregions, as I show in subsection 2.3.

To construct firms' wages, I first take away the differences in wages explained by workforce composition. I use a sample of all the workers employed in manufacturing in December of each year and regress the logarithm of their hourly wages (in constant 2005 prices) on workers' characteristics using the following specification:

$$\begin{aligned} \log\ wage_{kjlt} = \beta_{0t} &+ \beta_{1t}(age_{kt} - 35) + \beta_{2t}(age_{kt} - 35)^2/100 \\ &+ \beta_{3t}\ female_k + \beta_{4t}\ tenure_{kt} \\ &+ \sum_m \beta_{5mt}\ education_{kt} + \sum_p \beta_{6pt}\ occupation_{kt} + \mu_{jlt} + \nu_{kjlt}, \end{aligned} \tag{2.5}$$

where k denotes an individual, j denotes industry, l denotes microregion, t denotes year, and $female_k$ is an indicator for female, $tenure_{kt}$ is the tenure on the job in years, age_{kt} is the age in years, $education_{kt}$ and $occupation_{kt}$ are the full set of indicators for education and occupation categories, and μ_{jlt} is the industry–location–year fixed effect. I fit the specification (2.5) separately for each year, using the sample of all workers in Brazil employed in manufacturing in December of that year. The estimation results are presented in tables 21 and 22 of the appendix A.

After this, I obtain the firm specific wage level as the average wages paid to a 35 year old male production worker with a high school degree and zero tenure at the firm i:

$$w_{ijlt} = \frac{1}{K_{ijlt}} \sum_k \left(\hat{\beta}_0 + \hat{\mu}_{jlt} + \hat{\nu}_{kjlt} \right) \tag{2.6}$$

where K_{ijlt} is the number of employees in the firm in December of each year.

Finally, I estimate the wage change for each firm as a simple difference of the firm level wage:

$$\Delta w_{ijlt} = w_{ijlt} - w_{ijl,t-1}. \tag{2.7}$$

This measure is only defined for the firms who have workers both in periods t and $t-1$, and thus can only be constructed for surviving firms. I explain how I overcome this selection problem in section 4.

2.3 Cyclicality of local labor market conditions

Having introduced the measure of the labor market conditions, I can now describe the key facts on changes in labor market conditions over the business cycle. I outline four facts:

1. Though both labor market tightness and wages co-move across regions, there is substantial variation in labor market conditions across regions in any given year.
2. Labor market tightness responds strongly to local business cycle.
3. Prevailing wages responds to local business cycle as well. However, in microregions which are more exposed to increase in national minimum wage, wages are growing more independently of local business cycles.

The first fact emphasizes substantial variation in labor market conditions across regions. Figures 4a and 4b plot annual changes in labor market tightness across microregions as measured by employment to population ratio and by probability to be hired respectively. Median change in labor market tightness generally follows the same pattern as the growth of the national GDP per capita, but the common annual component explains only 12% of variation in changes in labor market tightness across regions if labor market tightness is measured by employment to population ratio, and 6% if labor market tightness is measured by probability to be hired. Over time, the interquartile range varies between 4.3% and 8.6% if measured by employment to population ratio and 9.7% and 21% if measured by probability to be hired. Figure 5 plots average wage change across microregions over time. Common annual component explains 36% of variation in wage change across regions, and wage changes are strongly correlated with the change in real national minimum wages. I discuss this correlation in detail below. However, the interquartile range in wage change varies between 3% and 5%, so the variation across regions at any given year in wage change is quite large as well.

The second fact establishes that labor market tightness varies over the local business cycle. Though the data on unemployment rates are not available at the microregion level, IBGE reports annual series on regional GDP and population for most microregions starting in 1999. Table 2 and 3 present the result of a regression of the change in labor market tightness on annual growth of regional GDP per capita. On average, one percentage point increase in GDP per capita is associated with 0.2 percentage point increase in employment to population ratio and 0.4 percentage point increase in probability to be hired. Moreover, this relationship holds after controlling for regional wage premium, size of the formal sector in the microregion and labor market tightness measured by total employment over population ratio.

The third fact points out that though wages respond to local business cycles as well, wages grow faster in regions with higher exposure to minimum wage increase. On average, a one percentage point increase in local GDP per capita is associated with 0.08 percentage point increase in wages (table 4). However, wage growth is significantly affected by the increase in minimum wage. Brazil has a nationally set nominal minimum wage, which is the same across regions and is adjusted approximately once a year. Although starting in 2002, states can impose their own minimum wage, it cannot be smaller than the nationally set minimum wage. Minimum wage grew substantially in 1997-2010 both in nominal and real terms. On average, minimum wage grew 10% annually in nominal terms, and 4% annually in real terms. In real terms, it decreased only twice during 1997-2010: in 1999 and in 2002, as in these years inflation reached 8.4% and 14.7% respectively.

Since RAIS provides information on individual level wages, I can measure how much microregions are affected by the change in minimum wage. For each microregion in the sample, I calculate what share of workforce in the last year would meet this year minimum wage requirements. This share varies from 0.3% to 90%, with the median around 10-12% (figure 7). Table 4 demonstrates, that in the regions where more than 20% of workforce is exposed to the minimum wage increase, wages grew 0.01 percentage points faster independently of local GDP growth, compared to the microregions with 0-7% exposure to minimum wage increase. This difference is large, since on average real wages grew at the rate of 0.46% annually.

3 Model of Local Labor Markets

In this section I outline the key mechanism through which the changes in labor market conditions affect employment growth at the firm level. I build a model of local labor markets with heterogeneous firms in subsection 3.1 and discuss how firms respond to labor demand shocks in subsection 3.2. I argue that changes in labor market conditions can affect firms through two margins: labor market tightness and prevailing wages. If hiring workers takes time, the value of opening a vacancy goes up whenever the market slackens (i.e. the ratio of vacancies to unemployment falls), and a firm has incentives to expand. Next, if firms hire workers on the same labor market and workers have non-zero bargaining power, a change in the potential wage which a newly hired worker can get on the market raises his outside options and will affect wages in all firms, as in Beaudry et al. (2012). Furthermore, I show that low-paying and high-paying firms are likely to respond to changes in labor market conditions differently, because high-paying firms have higher profits per worker and can sustain larger changes in wages.

3.1 Local labor market equilibrium

To model firms' employment and wages, I introduce firm heterogeneity into a continuous-time search and bargaining framework. I let firms differ in two parameters: flow revenue per worker and fixed cost of hiring. The first parameter affects firms' surplus from opening a new vacancy and the second one changes how expensive it is to expand. Together, these two parameters determine the optimal size of the firm, but only the flow revenue per worker affects firm-specific wages, which proves to be crucial for firm's response to shocks.

Workers in the model are looking for jobs in all industries, and they get some of the firm-specific surplus once they find a job. As a result, wages do not equalize across firms and wages paid by each firm depend on the distribution of productivity in the whole labor market, as in Beaudry et al. (2012). This wage setting can be regarded as a reduced form approximation of a second-price auction for a worker, suggested by Cahuc et al. (2006) and Flinn (2006).

I model the economy as L isolated locations which produce J traded goods, sold at the national price p_j. Each industry j in a location l is populated by a continuum of firms, who take the prices of goods as given, but can choose how many vacancies to post. Firms base their hiring decisions on labor market conditions, characteristics of their industry and location, and two firm-specific parameters: flow revenue per worker and cost of hiring. Firms can fill the posted vacancies from the pool of unemployed workers, but hiring takes time due to search frictions. Once a vacancy is matched with a worker, the firm and the worker split the surplus of the match according to Nash bargaining.

The prevailing vacancy filling rate and the average potential wage which a worker can get at location l are the two key equilibrium variables, which allow two locations with the same industry composition respond to the same shocks differently.[5] The average potential wages (denoted by $\bar{w}_l$) determines what fraction of the flow revenue the firm is able to retain as profits, and the vacancy filling rate (denoted by ϕ_l) determines how expensive it is to expand in size. The role of these

[5]Two regions with the same industrial composition can have different equilibria because of the region-specific revenue advantage and differences in population size between these two regions.

two variables in local employment growth is the main focus of this paper. For the ease of the exposition, I abstract from the other channels through which the industries can interact: local multipliers, migration and partial mobility across industries. However, I show in section 4 that my identification strategy is robust to these interactions as well.

Matching function. All firms hire workers on the same location-specific labor market. There are no economies of scale in hiring and workers don't observe firm characteristics before they are matched with a vacancy. As a result, an open vacancy at any firm is filled at a constant vacancy filling rate ϕ_l. The equilibrium vacancy filling rate ϕ_l is determined by the total number of vacancies posted by each industry in the location l, since I treat the number of workers in each location as fixed. Following a standard DMP model, I assume that the matching function exhibits constant returns to scale with parameter σ. Furthermore, I allow workers to be perfectly mobile across industries.[6] As a result, one additional unemployed worker increases the vacancy filling rate by the same rate in all firms and all the industries. Thus, firms from all industries respond to an increase in unemployment in the same way, and do not care about the composition of unemployment workers.

Denoting the number of unemployed workers by U_l, and the total number of vacancies by V_l, the total number of the new matches can be written as $V_l^{\sigma} U^{1-\sigma}$. Thus, the vacancy filling rate ϕ_l and the job arrival rate ψ_l are:

$$\phi_l = \left(\frac{V_l}{U_l}\right)^{-(1-\sigma)}, \tag{3.1}$$

$$\psi_l = \left(\frac{V_l}{U_l}\right)^{\sigma}. \tag{3.2}$$

Labor supply. Workers can be either employed or unemployed. Unemployed workers look for jobs in all industries independently of their previous employment.[7] I assume that search is random, and an unemployed worker meets a vacancy from an industry j and firm i with a probability proportional to the number of unfilled vacancies it has on the market. Thus, a worker receives a job offer from an industry j at the rate $\psi_l \eta_j$, where $\eta_{jl} = V_{jl}/V_l$ is the share of unfilled vacancies of industry j in the market and ψ_l is the job arrival rate. While unemployed, the worker receives per-period utility b, which can be thought of as the value of home-production or work at the informal sector. Denoting by J^u the value of unemployment and by J_j^e the expected value of employment at industry j, the value of unemployment can be written as:

$$\rho J_l^u = b + \psi_l \left(\sum_j \eta_j J_{jl}^e - J_l^u\right). \tag{3.3}$$

When a worker receives a job offer, a firm and a worker agree on the wage rate w_{ijl} according to the Nash bargaining rule, and the worker becomes employed. Firms in the same industry pay

[6] This assumption is made for simplicity and can be relaxed at the cost of introducing additional $(J-1)L$ parameters to the model. However, partial mobility across industries is required.

[7] This assumption can be relaxed if the detailed data on the composition of unemployed workers for each location is available, which is not the case of Brazil.

different wages because workers have non-zero bargaining power and receive some of the surplus of the match, and on the other hand workers cannot direct their search towards the higher paying firms due to search frictions. An employed worker can separate from a firm in two cases. Either the firm closes or scales down (endogenous separation), or the match is dissipated (exogenous separation), which occurs at rate δ. In steady-state the firm's revenue is constant, and the only source of separations is the dissipation rate. Denoting by J^e_{ijl} the value of employment at a firm ijl, the Bellman equation for it writes:

$$\rho J^e_{ijl} = w_{ijl} + \delta \left(J^u_l - J^e_{ijl} \right). \tag{3.4}$$

The value of employment at the industry j is the weighted average of employment at each firm i of industry j in the location l, where the probability to be employed at each firm is proportional to the share of its unfilled vacancies in the industry $\eta_{ijl} = \frac{V_{ijl}}{V_{jl}}$. Denoting by $w_{jl} = \sum_i \eta_{ijl} w_{ijl}$ the average wage the industry i pays, where the expectation is taken over the firm-specific parameters which will be described later, the expected value of employment at this industry is:

$$\rho J^e_{ijl} = \mathbb{E}\left[\eta_{ijl} J^e_{ijl} \right] = w_{jl} + \delta \left(J^u_l - J^e_{jl} \right). \tag{3.5}$$

Labor demand. Each firm i in industry j and location l receives flow revenue y_{ijl} from a filled vacancy, and there are no spillovers in revenue within the firm. Firms take y_{ijl} as given and only decide how many vacancies to post. I model the flow revenue $y_{ijl} = p_j + \zeta_l + \varepsilon_i$, where p_j is the price of the good, ζ_l is a location-specific revenue-advantage, and ε_i is the firm's revenue advantage. I assume that all three components of the flow revenue are independent from each other. Each firm is characterized by two parameters: advantage in revenue per worker ε_i and the fixed cost of hiring ξ_i. The revenue per worker advantage allows a firm to get higher profit per \$1 of wages paid, and represent firm's savings on marginal costs not associated with labor, such as the price of materials etc. A lower fixed hiring cost helps a firm to expand at a lower cost, and can arise can arise from a better hiring technology, a smaller bureaucratic burden associated with posting a vacancy etc. I do not impose any restrictions on the correlation between the revenue per worker and the fixed cost of hiring. Firms differ only in these parameters, and thus all firms with the same ε and ξ in the same industry and location get the same profits and make the same hiring decisions. The distribution of types in the equilibrium is determined by firms' entry to the market, similarly to (Melitz, 2003), and is discussed in detail below.

A vacancy brings profits only when it is filled, and firms pay a flow cost c to keep a vacancy open. Denoting by J^v_{ijl} the value of an open vacancy and by J^f_{ijl} the value of a filled vacancy, the value of an open vacancy can be written as:

$$\rho J^v_{ijl} = -c + \phi_l \left(J^f_{ijl} - J^v_{ijl} \right). \tag{3.6}$$

Once a vacancy is filled, the firm receives a stream of profits $y_{ijl} - w_{ijl}$, where w_{ijl} is the wage paid by firm ijl. The filled vacancy can be destroyed at the exogenous rate δ, and then it becomes open again. Thus, the value of a filled vacancy is:

$$\rho J_{ijl}^{f} = y_{ijl} - w_{ijl} + \delta \left(J_{ijl}^{v} - J_{ijl}^{f} \right). \tag{3.7}$$

To open a vacancy, firms have to pay a fixed cost, which increases with the size of the firm, denoted by E_{ijl}. This cost varies across firms: firm cost advantage ξ_i can make it lower. To post a vacancy a firm has to pay $\left(E_{ijl}/\xi_i\right)^{\theta}$. Since in the equilibrium the value of the marginal vacancy opened has to equal the fixed cost of its creation, this condition determines the size of each firm despite of the fact that there are no complementarities in production between jobs within the same firm.

In steady state, the size of each firm is defined by two conditions. First, the size of the firm has to be constant. That is, the number of workers who leave the firm is the same as the number of workers who join it:

$$\delta E_{ijl} = \phi_l V_{ijl}. \tag{3.8}$$

Second, the value of the last vacancy posted equals the cost to create it:

$$J_{ijl}^{v} = \left(\frac{E_{ijl}}{\xi_i} \right)^{\theta}. \tag{3.9}$$

After solving for the value of an open vacancy and using equations (3.8) and (3.9) to determine the size of the firm, I obtain the following expression for the steady-state size of the firm:

$$E_{ijl} = \xi_i \left(\frac{\phi_l/(\rho+\delta)}{\rho+\delta+\phi_l} \right)^{1/\theta} \left(y_{ijl} - w_{ijl} - \frac{\rho+\delta}{\phi_l} c \right)^{1/\theta}. \tag{3.10}$$

Thus, the size of the firm compared to its rivals in the same industry and location is determined by the revenue advantage ε_i and the hiring cost ξ_i. A firm can be larger either because it is more profitable and has higher ε_i, or because it is cheaper for it to hire new workers and it has higher ξ_i. At the same time, if the industry j is more profitable than others, or if location l has a comparative advantage, it will tend to have more large firms compared to other industries and/or locations.

Wages. Once a worker and a vacancy meet, they bargain to split the surplus. Though neither the worker nor the firm can direct their search to a particular type of firms (e.g. larger or more profitable firms) or workers (e.g. workers who have previously worked in the same industry), they observe each others' types when they are matched. That is, the worker knows the firm's flow revenue and its fixed hiring cost, and the firm knows the worker's previous employment history. The resulting wage is a solution to the following Nash bargaining rule:

$$J_{ijl}^{f} - J_{ijl}^{v} = \kappa \left(J_{ijl}^{e} - J_{l}^{u} \right). \tag{3.11}$$

After substituting in the expressions for workers's and firm's surpluses, and denoting by $\bar{w}_l = \sum_j \eta_{jl} w_{jl}$ the average potential wage paid in a location l, I can write the wage paid by the firm ijl

with the cost advantage level ε_i as[8]:

$$w_{ijl} = \frac{\rho+\delta}{\Upsilon_{1,l}}\left(p_j + \zeta_l + \varepsilon_i + c\right) + \kappa \frac{\Upsilon_{2,l}}{\Upsilon_{1,l}}\left((\rho+\delta)b + \psi_l \bar{w}_l\right), \tag{3.12}$$

where $\Upsilon_{1,l} = (\rho+\delta+\phi_l)\kappa + (\rho+\delta)$ and $\Upsilon_{2,l} = (\rho+\delta+\phi_l)/(\rho+\delta+\psi_l)$.

Equation (3.12) demonstrates that a firm pays a higher wage if it's more profitable or if its workers have better outside options on the labor market or at home production. Since workers can look for a job in all the industries, equilibrium wages in any particular firm is driven upwards whenever an average firm in the same industry or any other industries can pay higher wages. However, the role of this effect is smaller if workers have low bargaining power of if the labor market is slack, i.e. there are plenty of unemployed workers but few jobs.

Entry and exit. There are N potential entrants in each industry j and location l. Each potential entrant draws parameters ε_i and ξ_i separately from the known distribution, and decides weather to enter the market. Once a firm enters, it chooses how many workers to hire and then posts vacancies. A firm with per-vacancy profitability level $J^v_{ijl}(\varepsilon)$ would like to be of size $E_{ijl}(\varepsilon,\xi) = \xi_i\big(J^v_{ijl}(\varepsilon)\big)^\theta$. In addition, since entrants draw ε_i and ξ_i independently, there can be a non-trivial size distribution of firms at any profit level, though more profitable firms will tend to be bigger, because they can sustain a higher fixed cost of creating a vacancy. Each firm has to be profitable and be able to hire non-negative number of workers. Since there is no cost to start a business, in equilibrium only firms with $J^v_{ijl}(\varepsilon) \geq 0$ and $E_{ijl}(\varepsilon,\xi) \geq 0$ enter the market. The marginal entering firm type, denoted by ε^*_{jl} writes as:

$$\varepsilon^*_{jl} = w_{ijl}(\varepsilon^*_{jl}) - p_j - \zeta_l + \frac{\rho+\delta}{\phi_l}c. \tag{3.13}$$

Aggregation. When firms make their hiring decisions, they take employment and wages in other firms as given, but average firm size and average wage paid in each industry have to be consistent with the optimal strategies of individual firms.

The industry size is the total number of workers employed by all firms who are active in the market, and is driven by the truncation parameter ε^*_{jl}. The size of industry j in location l is given by:

$$E_{jl} = \mathbb{E}[\xi_i]\Big(\frac{\kappa\phi_l}{\Upsilon_{1,l}(\rho+\delta)}\Big)^{1/\theta}\mathbb{E}\left[\Big(y_i - \frac{b+\psi_l\bar{w}_l/(\rho+\delta)}{\rho+\delta+\psi_l} - \frac{\kappa+1}{\kappa}\frac{\rho+\delta}{\phi_l}c\Big)^{1/\theta}\right]. \tag{3.14}$$

The average potential wage which a worker can get in the location l is:

$$\bar{w}_l = \frac{1}{1+\kappa\Upsilon_{2,l}}\left(\sum_j \eta_{jl}p_j + \zeta_l + c + \sum_j \eta_{jl}\bar{\varepsilon}_{jl}\right) + \frac{\kappa\Upsilon_{2,l}}{1+\kappa\Upsilon_{2,l}}b, \tag{3.15}$$

[8] The worker's and the firm's surpluses are, respectively:

$$J^f_{ijl} - J^v_{ijl} = \frac{1}{\rho+\delta+\phi_l}\left(p_j + \zeta_l + \varepsilon_i + c - w_{ijl}\right)$$

$$J^e_{ijl} - J^u_{jl} = \frac{1}{\rho+\delta+\psi_l}\left(w_{ijl} - b + \frac{\psi_l}{\rho+\delta}(w_{ijl} - \bar{w}_l)\right)$$

where $\bar{\varepsilon}_{jl}$ is the average type of the firm in the industry j and location l, defined as $\bar{\varepsilon}_{jl} = \mathbb{E}[E_{ijl}/E_{jl}\,\varepsilon_i]$

3.2 Employment growth in response to shocks

Having derived the local labor market equilibrium in the steady-state in subsection 3.1, I can turn to the firms' responses to unanticipated revenue or hiring cost shocks. I consider four types of shocks: three types of revenue shocks and a hiring cost shock. Firm's revenue might change due to nationwide shocks to the price of a good $\mathrm{d}p_j$, which are common across firms and locations, location specific shocks to the location comparative advantage $\mathrm{d}\zeta_l$, which are common across all firms in the same location, or due to idiosyncratic revenue shocks $\mathrm{d}\varepsilon_i$, which are firm specific and independent across firms. A firm can also experience an idiosyncratic shock to its hiring cost $\mathrm{d}\xi_i$. I will assume that all four types of shocks are mean zero and orthogonal to each other. Furthermore, the firm's idiosyncratic shock is orthogonal to the firm's steady-state value of profit advantage ε_i. However, I will not impose such a restriction on shocks to prices.

I consider the shocks to be transitory and unanticipated by the firm. Thus, I model firms' responses to these shocks by analyzing the deviations from the steady state equilibrium at the local labor market. After linearizing the equation for the size of the firm (3.10), its response to the shocks is given by:

$$\tilde{E}_{ijl} = \alpha_{ijl}\tilde{\psi}_l + \Omega_{ijl}\mathrm{d}w_{ijl} - \Omega_{ijl}(\mathrm{d}p_j + \mathrm{d}\zeta_l + \mathrm{d}\varepsilon_i) + \tilde{\xi}_i, \tag{3.16}$$

where $\alpha_{ijl} = -\frac{\sigma}{1-\sigma}\frac{1}{\theta}\left[\frac{\rho+\delta}{\rho+\delta+\phi_l} + \frac{\rho+\delta}{\phi_l}c\left(y_{ijl} - w_{ijl} - \frac{\rho+\delta}{\phi_l}c\right)^{-1}\right]$ and $\Omega_{ijl} = -\frac{1}{\theta}\left(y_{ijl} - w_{ijl} - \frac{\rho+\delta}{\phi_l}c\right)^{-1}$. In equation (3.16), $\tilde{x} = \mathrm{d}x/x$ denotes the percentage deviation from the steady state of the variable x, α_{ijl} is the elasticity of the labor demand with respect to change in the job arrival rate ψ_l, and Ω_{ijl} is the firm-specific is a semi-elasticity of labor demand with respect to wage change.

Firm's employment growth has four components. The first two components, $\alpha_{ijl}\tilde{\psi}_l$ and $\Omega_{ijl}\mathrm{d}w_{ijl}$ arise from the change in the labor market conditions in response to shocks, while the last two components, $-\Omega_{ijl}(\mathrm{d}p_j + \mathrm{d}\zeta_l + \mathrm{d}\varepsilon_i)$ and $\tilde{\xi}_i$, represent the direct effect of shock on firm's size. An increase in the price of a good $\mathrm{d}p_j$, in the location comparative advantage $\mathrm{d}\zeta_l$ or in the idiosyncratic term of the firm's revenue advantage $\mathrm{d}\varepsilon_i$ raise the flow revenue to the firm, thus making new vacancies more attractive and stimulating employment growth (i.e. $\Omega_{ijl} < 0$). At the same time, a shock to a price of a good p_j shifts the equilibrium wage at the firm i upwards, and also affect the employment and wage at other firms in the same location l, thus changing the workers' average potential wage at the market $\bar{w}_l$. Similarly, p_j affects the overall level of employment in the location l and changes the prevailing job arrival rate ψ_l. Firms take as given both the arrival rate ψ_l and the wage w_{ijl} they have to pay conditional on their flow revenue y_{ijl}. A lower arrival rate ψ_l or a lower wage w_{ijl} lead to employment growth, i.e. $\alpha_l < 0$ and $\Omega_{ijl} < 0$. The magnitude of this response to the change in the local labor market conditions, driven by parameters α_{ijl} and Ω_{ijl}, is the main focus of this paper.

Both labor demand elasticity with respect to job arrival rate and with respect to wage change vary across firms. The elasticity with respect to change in job arrival rate writes as[9]:

$$\begin{aligned}\alpha_{ijl} &= -\frac{\sigma}{1-\sigma}\frac{1}{\theta}\left[\frac{\rho+\delta}{\rho+\delta+\phi_l} + \frac{\rho+\delta}{\phi_l}c\left(y_{ijl} - w_{ijl} - \frac{\rho+\delta}{\phi_l}c\right)^{-1}\right] \qquad (3.17)\\ &= -\frac{\sigma}{1-\sigma}\frac{1}{\theta}\left[\frac{\rho+\delta}{\rho+\delta+\phi_l} + \frac{c}{\rho+\delta+\phi_l}\left(\frac{E_{ijl}}{\xi_{ijl}}\right)^{-\theta}\right],\end{aligned}$$

and the elasticity with respect to wage changes is:

$$\begin{aligned}\Omega_{ijl} &= -\frac{1}{\theta}\left(y_{ijl} - w_{ijl} - \frac{\rho+\delta}{\phi_l}c\right)^{-1} \qquad (3.18)\\ &= -\frac{1}{\theta}\frac{\phi_l/(\rho+\delta)}{\rho+\delta+\phi_l}c\left(\frac{E_{ijl}}{\xi_i}\right)^{-\theta}.\end{aligned}$$

The labor demand elasticity with respect to job arrival rate depends on two parameters: how tight the market is, i.e. how easy it is to find workers, and on the cost of keeping the vacancy open. Since the costs of keeping an open vacancy are the same across firms, but expected profits per worker depend on the wage and flow revenue, the labor demand elasticity with respect to job arrival rates varies with the profits per workers. The labor demand elasticity with respect to wages is directly linked to profits per worker, ad thus diminished with profits as well.

Thus, both larger and higher paying firms are less sensitive to changes in labor market conditions. However, firms of the same size can have different labor demand elasticities, while wages has a one-to-one relationship for the semi-elasticity of demand. This is the case because large size can be a result of either higher profitability or lower hiring costs, while a higher wage level can only be sustained by higher profits. In fact, wage which the firm pays is a sufficient statistics for its profit per worker. The profit per worker can be expressed as a function of wages:

$$y_{ijl} - w_{ijl} - \frac{\rho+\delta}{\phi_l}c = \kappa\frac{\rho+\delta+\phi_l}{\rho+\delta}w_{ijl} - \frac{\rho+\delta+\phi_l}{\phi_l}c - \kappa\frac{\rho+\delta+\phi_l}{\rho+\delta+\psi_l}\left(b + \frac{\psi_l}{\rho+\delta}\bar{w}_l\right). \qquad (3.19)$$

Note that the right hand side of the equation (3.19) has location specific parameters (indexed by l), but not industry specific parameters (which would have been index by j). This is the case because all firms in the same labor market give the same share of their revenue to workers, since workers outside options do not depend on the industry in which they currently work or have worked before. This is a result of the assumption of the perfect mobility of workers across industries. This representation allows me to rewrite firm specific elasticities solely as functions of firm wages and location specific parameters:

$$\alpha_{ijl} = a_{0,l} + \frac{1}{a_{1,l} + a_{2,l}w_{ijl}}, \qquad (3.20)$$

$$\Omega_{ijl} = \frac{1}{\beta_{1,l} + \beta_{2,l}w_{ijl}}, \qquad (3.21)$$

[9]The elasticity with respect to arrival rates is derived by first finding the elasticity with respect to vacancy filling rate $\tilde{\phi}_l$ and using the fact that $\tilde{\psi}_l = -\frac{\sigma}{1-\sigma}\tilde{\phi}_l$

where $\beta_{1,l} = \theta \frac{\rho+\delta+\phi_l}{\phi_l} c + \theta\kappa\frac{\rho+\delta+\phi_l}{\rho+\delta+\psi_l}\big(b + \frac{\psi_l}{\rho+\delta}\bar{w}_l\big)$, $\beta_{2,l} = -\theta\kappa\frac{\rho+\delta+\phi_l}{\rho+\delta}$, and $a_{0,l} = -\frac{1}{1-\sigma}\frac{1}{\theta}\frac{\rho+\delta}{\rho+\delta+\phi_l}$, $a_{1,l} = -\frac{1-\sigma}{\sigma}\frac{\phi_l}{\rho+\delta}\frac{1}{c}\beta_{1,l}$, $a_{2,l} = \frac{1-\sigma}{\sigma}\frac{\phi_l}{\rho+\delta}\frac{1}{c}\beta_{2,l}$.

This parametrization will prove to be extremely useful for the estimation of the model, which I discuss in detail in section 5.3. I turn next to the identification strategy, which will allow me to separate the movements in the local labor market conditions $\tilde{\psi}_l$ and $\mathrm{d}w_{ijl}$ from the direct effect of shocks $\mathrm{d}\varepsilon_i$, $\mathrm{d}p_j$ and $\mathrm{d}\zeta_l$.

4 Sources of Exogenous Variation in Labor Market Conditions

The goal of the first part of the paper is the estimation of labor demand elasticity at the firm level in the equation 4.2. I am interested both in the elasticity with respect to changes in labor market tightness, denoted by α_{ijl}, and with respect to changes in wages, denoted by Ω_{ijl}.

$$\tilde{E}_{ijlt} = \alpha_{ijl}\tilde{\psi}_{lt} + \Omega_{ijl}\mathrm{d}w_{ijlt} + u_{ijlt}, \tag{4.1}$$

$$u_{ijlt} = -\Omega_{ijl}\big(\mathrm{d}p_{jt} + \mathrm{d}\varepsilon_{it} + \mathrm{d}\zeta_{lt}\big) + \tilde{\xi}_{it}. \tag{4.2}$$

There are two identification problems associated with estimating labor demand elasticity: omitted variable bias, because the realizations of the shocks are not observed by an econometrician, and selection into surviving firms.

Omitted variable bias is typical for demand estimation, because demand shifter are usually unobserved. Thus an increase (decrease) in firm's revenue leads both to a wage increase (decrease) and employment growth (decline). This mechanism creates a positive correlation between the error term u_{ijlt} and the wage changes. For the same reason, if a firm is large enough to affect the overall employment level at the local labor market, the error term can also be correlated with the change in the labor market tightness $\tilde{\psi}_{lt}$.

Selection arises because wage changes are not observed for the exiting firms, as they do not have any employees after they exit. This leads to a positive correlation between the error term and wages as well, since surviving firms have smaller negative (or larger positive) revenue shocks.

Though the signs of the labor demand elasticities are expected to be negative, both simultaneity and selection bias the estimates upwards in OLS and can produce a positive sign of the estimated elasticities. To overcome the simultaneity problem, I instrument the changes in labor market conditions with Bartik shocks, a widely used measure of local labor demand shocks, and changes in the nationwide minimum wage in Brazil. To avoid selection, I use wage changes at a reference firm in the same microregion as a measure of wage change for exiting firms. In the next two subsections I describe the instrument strategy first and then explain how the reference firm is constructed.

4.1 Instruments for labor market conditions

To estimate the labor demand elasticity, one needs to find shifters of the firm level wages and labor market tightness which are uncorrelated with the error term u_{ijlt} (equation (4.2)). I use two such shifters: Bartik shocks, and firm's exposure to the raise in the nationwide minimum wage in Brazil. The error term u_{ijlt} has four unobserved components: the idiosyncratic shock to the firm's revenue advantage $\mathrm{d}\varepsilon_{it}$, the idiosyncratic shock to the firm's hiring cost advantage $\tilde{\xi}_{it}$, the nationwide demand shock $\mathrm{d}p_{jt}$ and the location specific demand shock $\mathrm{d}\zeta_{lt}$. I argue that both of the proposed shifters are independent of the location specific demand shock and the firm specific idiosyncratic shocks. However, the instruments can be potentially correlated with the nationwide demand shock in each industry. Therefore, I construct a control variable which allows me to account for the nationwide demand shock $\mathrm{d}p_{jt}$ explicitly.

Minimum wage instrument. Brazil has a federally mandated minimum wage, which imposes a limit on a monthly salary for workers in the formal sector and was adjusted on average once a year during 1997-2010 (figure 6). For each firm, I calculate the share of workers in year $t-1$ whose monthly nominal wages was below the minimum wage threshold in year t, i.e. one year in advance, and use it as an instrument for the firm's wage change between $t-1$ and t.

Firms vary substantially in the share of workers who are subject to wage increase in the next year – an average firm in the sample was paying 13% of workforce less than the minimum wage, with a standard deviation of 26% (see table 5). Furthermore, though minimum wage raise is binding for a larger fraction of firms in low wage microregions, even high wage microregions have some firms who have to raise wages to comply with the federal minimum. A a result, the minimum wage instrument provides a source of variation in wage change across firms within the same local labor market.

Since I use the share of workers in year $t-1$ with wages below the minimum wage in t, this measure is not correlated with the idiosyncratic changes in revenue $\mathrm{d}\varepsilon_{it}$ and hiring cost $\tilde{\xi}_{it}$ as long as these shocks are not correlated with the lagged wage level $w_{ijl,t-1}$. Moreover, because minimum wage are set at the national level, they are uncorrelated with the local demand shocks $\mathrm{d}\zeta_{lt}$.

Bartik instruments. Bartik shocks measure predicted growth rate in employment (or wages) at the local labor market if each industry in that location grew at the same rate as the nationwide average. Bartik shocks were first used to estimate the slope of the labor demand by Beaudry et al. (2014). The intuition is straightforward. An increase in demand for labor makes workers more expensive and harder to hire. As a result, the labor market tightens (i.e. vacancy filling rate decreases and the job arrival rate increases), and the wages each firm has to pay go up. The instrument is relevant as long as firms from different industries hire workers at the same labor market, i.e. workers are at least partially mobile across industries.

I use the following instrument for the change in the labor maker tightness:

$$\widehat{NEG}_{lt} = \sum_j s_{jl,t-1} NEG_{jt,-l}, \tag{4.3}$$

where $s_{jl,t-1} = \frac{E_{jl,t-1}}{E_{l,t-1}}$ is the share of industry j in total employment in the microregion l in year $t-1$ and $NEG_{jt,-l}$ is the nationwide average net employment growth of employment in the industry j, *excluding* the microregion l, calculated as $NEG_{jt,-l} = \sum_{m\neq l} \frac{E_{jl,t-1}}{\sum_{m\neq l} E_{jl,t-1}} NEG_{jlt}$.

The equilibrium condition implies that the change in the job arrival rate is proportional to the change in demand for labor at the local labor market:

$$\tilde{\psi}_{lt} = \frac{\sigma}{2-\sigma}\tilde{E}_{lt}, \tag{4.4}$$

where σ is the parameter of the matching function, and $\tilde{E}_{lt}$ is the change in the employment in the labor market. The Bartik shock $\widehat{NEG}_{lt}$ is a predictorof $\tilde{E}_{lt}$ and thus has a direct impact on the change in the job arrival rate $\tilde{\psi}_{lt}$.

Following Beaudry et al. (2012), I construct the Bartik shocks for the change in wages as follows:

$$\widehat{\mathrm{d}w}_{1,lt} = \sum_j s_{jl,t-1} WG_{jt,-l}\, w_{jl,t-1}, \tag{4.5}$$

$$\widehat{\mathrm{d}w}_{2,lt} = \sum_j s_{jl,t-1} NEG_{jt,-l}\, w_{jl,t-1}, \tag{4.6}$$

where $WG_{jt,-l}$ is the nationwide average wage growth rate in the industry j in year t, excluding microregion l. These instruments capture predicted changes in the average potential wages $\bar{w}_{lt}$, which a worker can get if he looks for a job. Since wages are set through the Nash bargaining, each firm has to match $\bar{w}_{lt}$ to be able to make a hire. Thus, an increase in the average potential wage causes an increases in the firm level wage *regardless* of firm level revenue changes. As a result, these changes provide identifying variation in wages.

Average potential wage can change either due to the wage changes in each of the industries or because one of the industries grew substantially:

$$\mathrm{d}\bar{w}_{lt} = \sum_j s_{jl,t-1}\mathrm{d}w_{jlt} + \sum_j \mathrm{d}s_{jlt} w_{jl,t-1}. \tag{4.7}$$

Bartik shocks for wages (4.5) and (4.6) correspond to each of these channels.

By construction all the Bartik instruments $\widehat{NEG}_{lt}$, $\widehat{\mathrm{d}w}_{1,lt}$ and $\widehat{\mathrm{d}w}_{2,lt}$ exclude the information from the own microregion l in year t, and use the lagged industrial composition in the location l. This makes the identification requirements relatively weak. First, there has to be no spatial correlation in wages or employment growth across cities. This ensures that the location demand shock $\mathrm{d}\zeta_{lt}$ is orthogonal to the nationwide employment and wage trends. Note that this assumption does not rule out migration between the nearly regions in response to shocks (e.g. when one region is doing better than the other), but requires instead that these migration flows are small enough not to affect the nationwide trends.

Second, to be able to use lagged levels of firm wages as instruments, location demand shocks $\mathrm{d}\zeta_{lt}$ have to be orthogonal to stead-state values of the firm revenue advantage ε_i and location revenue advantage ζ_l. The requirement implies that local markets with both small and large wage premia can receive large positive (or negative) shocks. However, this assumption allows for heteroskedasticity or autocorrelation in location demand shocks.

Together these two assumptions ensure that Bartik shocks are not correlated with the location demand shocks. Finally, an assumption that idiosyncratic shocks to firm's revenue and hiring advantage are orthogonal to industry and location demand shocks implies that Bartik shocks are uncorrelated with the firm-specific shocks as well.

However, since Bartik shocks capture trends in industrial growth, they are likely to be correlated with the own industry shock $\mathrm{d}p_{jt}$. This correlation can arise either because of the income effect or due to increase in demand for the intermediate goods. Labor demand growth in any industry leads to an increase of the overall income level in a region, which, in turn, results in higher demand for locally produced goods and services and newly created jobs in the non-tradable sector. This effect is well-documented and can be quite large (Moretti, 2010). Growth of labor demand in one industry can affect another industry if the latter industry produces inputs to the former industry. For instance, if ethanol producers are expanding because the prices on ethanol went up, they will also purchase more sugarcane from sugarcane producers, who, in turn, will hire more labor. To ensure that my estimates are not contaminated by the income effect, I focus on the traded goods industries only. To deal with the potential increase in demand for intermediate goods within the country, I develop a control variable strategy to account for the demand shock in own industry explicitly.

Control variable for nationwide demand shocks. I have argued that the minimum wage instrument and Bartik instruments are orthogonal to firms' idiosyncratic shocks and the local demand shocks under mild requirements. However, both of these instruments are correlated with the nationwide demand shocks in each industry $\mathrm{d}p_{jt}$. Bartik shocks represent nationwide trends in employment in wages projected at the local industrial composition. The shocks to different industries $\mathrm{d}p_{jt}$ are likely to be correlated with each other, because the output of some industries is an input for other industries. Similarly, the minimum wage is adjusted more often if the economy is growing faster, and thus the minimum wage instrument is likely to be correlated with the nationwide demand shock $\mathrm{d}p_{jt}$ as well.

If the nationwide shocks $\mathrm{d}p_{jt}$ were observed, one could explicitly control for them in the estimation equation (4.1). Alternatively, one could estimate equation (4.1) with industry-year fixed effects if all firms within the industry were responding to the industry specific shocks in the same way[10]. In both cases, the error term would become $u'_{ijlt} = \Omega_{ijl}\big(\mathrm{d}\varepsilon_{it} + \mathrm{d}\zeta_{lt}\big) + \tilde{\xi}_{it}$, which is orthogonal to both instruments. Based on this intuition, I propose a control variable approach to account for the nationwide demand shocks $\mathrm{d}p_{jt}$.

The wage change in firm i in industry j writes as:

$$\mathrm{d}w_{ijlt} = -\frac{\kappa\phi_l}{\Upsilon_{1,l}}\tilde{\phi}_{lt}w_{ijlt} + \frac{\rho+\delta}{\Upsilon_{1,l}}\big(\mathrm{d}p_{jt} + \mathrm{d}\zeta_{lt} + \mathrm{d}\varepsilon_{it}\big) + \kappa\frac{\Upsilon_{2,l}}{\Upsilon_{1,l}}\mathrm{d}\Psi_{lt}, \tag{4.8}$$

where $\mathrm{d}\Psi_{lt} = \big((\rho+\delta)b + \psi_{lt}\bar{w}_{lt}\big)\tilde{\Upsilon}_{2,lt} + \psi_{lt}\mathrm{d}\bar{w}_{lt} + \bar{w}_{lt}\mathrm{d}\psi_{lt}$. Then, the deviation of the wage change

[10] This is a strategy used in Beaudry et al. (2012) and Beaudry et al. (2014).

in firm i from the average wage change in the market l, denoted by $\mathrm{d}w_{lt}$ is:

$$\begin{aligned}\mathrm{d}w_{ijlt} - \mathrm{d}w_{lt} &= -\frac{\kappa\phi_{lt}}{\Upsilon_{1,l}}\tilde{\phi}_{lt}(w_{ijlt} - w_{lt}) \\ &\quad + \frac{\rho+\delta}{\Upsilon_{1,l}}\left(\mathrm{d}p_{jt} - \sum_j s_{jl,t-1}\mathrm{d}p_{jt}\right) + \frac{\rho+\delta}{\Upsilon_{1,l}}\left(\mathrm{d}\varepsilon_{it} - \mathrm{d}\varepsilon_{lt}\right), \end{aligned} \tag{4.9}$$

where $\mathrm{d}\varepsilon_{lt} = \sum_i s_{il,t-1}\mathrm{d}\varepsilon_{it}$. Estimates of the term $\frac{\rho+\delta}{\Upsilon_{1,l}}\left(\mathrm{d}p_{jt} - \sum_j s_{jl,t-1}\mathrm{d}p_{jt}\right)$ can be obtained as microeregion-industry-year fixed effects in a regression of $\mathrm{d}w_{ijlt} - \mathrm{d}w_{lt}$ on $\tilde{\phi}_{lt}(w_{ijlt} - w_{lt})$. Then, these estimates can be used to construct the control variable $\widehat{\mathrm{d}p}_{jlt}$:

$$\begin{aligned}\widehat{\mathrm{d}p}_{jlt} &= \sum_{m\neq l}\frac{E_{m,t-1}}{E_{t-1}}\frac{\rho+\delta}{\Upsilon_{1m}}\left(\mathrm{d}p_{jt} - \sum_j s_{jm,t-1}\mathrm{d}p_{jt}\right) \\ &= \left(\sum_{m\neq l}\frac{E_{m,t-1}}{E_{t-1}}\frac{\rho+\delta}{\Upsilon_{1,m}}\right)\mathrm{d}p_{jt} - \left(\sum_{m\neq l}\frac{E_{m,t-1}}{E_{t-1}}\frac{\rho+\delta}{\Upsilon_{1,m}}\sum_j s_{jm,t-1}\mathrm{d}p_{jt}\right). \end{aligned} \tag{4.10}$$

First, note that just as Bartik shocks, $\widehat{\mathrm{d}p}_{jlt}$ excludes the information from the microregion l in period t and thus varies across microregions. Second, $\widehat{\mathrm{d}p}_{jlt}$ is a linear function of $\mathrm{d}p_{jt}$ and thus $\mathrm{d}p_{jt}$ can be expressed as:

$$\mathrm{d}p_{jt} = \lambda_{0,lt} + \lambda_{1,l}\,\widehat{\mathrm{d}p}_{jlt} + \nu_{jlt}. \tag{4.11}$$

Therefore, the main estimation equation (4.1) can be redefined as follows:

$$\tilde{E}_{ijlt} = \alpha_{ijl}\tilde{\psi}_{lt} + \Omega_{ijl}\mathrm{d}w_{ijlt} - \Omega_{ijl}\big(\lambda_{0,lt} + \lambda_{1,l}\,\widehat{\mathrm{d}p}_{jlt}\big) + u'_{ijlt}, \tag{4.12}$$

$$u'_{ijlt} = -\Omega_{ijl}\big(\mathrm{d}\varepsilon_{it} + \mathrm{d}\zeta_{lt}\big) + \tilde{\xi}_{it} + \nu_{jlt}. \tag{4.13}$$

Since the error term u'_{jilt} no longer contains the nationwide demand shock $\mathrm{d}p_{jt}$, the minimum wage and the Bartik instruments can be used to consistently estimate the labor demand elasticity parameters α_{ijl} and Ω_{ijl}. For this assumption to hold, it is required that prices are set nationally, i.e. there is no input-output relationship between industries which affects the firm's revenue in a different way in locations l and k.

The downside of the control variable approach is the increase in the number of parameters to be estimated: the nuisance parameters $\lambda_{0,lt}$ and $\lambda_{1,l}$ need to be estimated as well. However, since by construction $\widehat{\mathrm{d}p}_{jlt}$ excludes changes in wages in the own market l, $\widehat{\mathrm{d}p}_{jlt}$ is a valid instrument for the equation (4.12) as well.

4.2 Unobserved wage changes for exiting firms

Information on employment growth, firm wage and firm size is available for all firms with non-zero employment in year $t-1$. However, wage changes are unobserved for exiting firms in year t.

Using only the sample of surviving firms to estimate the equation (4.1) would lead to inconsistent estimates of the labor demand elasticities, since firms with large negative idiosyncratic shocks will not be taken into account.

The model implies that the difference in the wage change in year t between two firms in the same industry and microregion is proportional to the difference in wages in year $t-1$. Denoting by $\mathrm{d}w_{1jlt}$ the wage change in the reference firm (e.g. the firm with the median wage in the industry j and microregion l) this relationship writes as:

$$\mathrm{d}w_{ijlt} - \mathrm{d}w_{1jlt} = -\frac{\kappa\phi_l}{\Upsilon_{1,l}}\tilde{\phi}_{lt}(w_{ijl,t-1} - w_{1jl,t-1}) + \frac{\rho+\delta}{\Upsilon_{1,l}}(\mathrm{d}\varepsilon_{it} - \mathrm{d}\varepsilon_{1t}). \tag{4.14}$$

Plugging this expression back into the equation for the employment growth at the firm level (4.12), I obtain a modified equation for the exiting firms:

$$\begin{aligned}\tilde{E}_{ijlt} &= \alpha_l\tilde{\phi}_{lt} - \Omega_{ijl}\Big(\mathrm{d}w_{1jlt} + \gamma_{1,l}\,\tilde{\phi}_{lt}(w_{ijl,t-1} - w_{1jl,t-1}) + \gamma_{0,lt}\Big)\\ &\quad + \Omega_{ijl}\big(\lambda_{0,lt} + \lambda_{1,l}\,\widehat{\mathrm{d}p}_{jlt}\big) + u''_{ijlt},\end{aligned} \tag{4.15}$$

where $u''_{ijlt} = u'_{ijlt} + \frac{\rho+\delta}{\Upsilon_{1l}}\,\mathrm{d}\varepsilon_{it}$, $\gamma_{1,l} = -\frac{\kappa\phi_l}{\Upsilon_{1,l}}$, and $\gamma_{0,lt} = \frac{\rho+\delta}{\Upsilon_{1,l}}(\mathrm{d}\varepsilon_{it} - \mathrm{d}\varepsilon_{1t})$. The two equations (4.12) and (4.15) can be combined into a new estimation equation:

$$\begin{aligned}\tilde{E}_{ijlt} = \alpha_{ijl}\tilde{\psi}_{lt} &+ \Omega_{ijl}\,\mathrm{d}w_{ijlt}\,\mathbb{1}\{survival_{ijlt}\} + \Omega_{ijl}\,\mathrm{d}w_{1jlt}\,\mathbb{1}\{exit_{ijlt}\}\\ &+ \Omega_{ijl}\big(\gamma_{0,lt} + \gamma_{1,l}\,\tilde{\psi}_{lt}(w_{ijl,t-1} - w_{1jl,t-1})\big)\mathbb{1}\{exit_{ijlt}\}\\ &- \Omega_{ijl}\big(\lambda_{0,lt} + \lambda_{1,l}\,\widehat{\mathrm{d}p}_{jlt}\big) + u'''_{ijlt},\end{aligned} \tag{4.16}$$

where the combined error term is $u'''_{ijlt} = \Big(-\Omega_{ijl} + \frac{\rho+\delta}{\Upsilon_{1l}}\,\mathbb{1}\{exit_{ijlt}\}\Big)\mathrm{d}\varepsilon_{it} - \Omega_{ijl}\mathrm{d}\zeta_{lt} + \tilde{\xi}_{it} + \nu_{jlt}$. Parameters $\gamma_{1,l}$ and $\gamma_{0,lt}$ are nuisance parameters associated with firms' exit and will be estimated along with parameters of interest.

Equation (4.16) can be estimated using the same set of instruments as the equation (4.12). To see that, note that each of the shocks $\mathrm{d}\varepsilon_{it}$, $\mathrm{d}\zeta_{lt}$ and $\tilde{\xi}_{it}$ is not correlated with each of the instruments, and thus the error term u'''_{ijlt} is not correlated with the original instruments as well.

However, estimation of equation (4.16) requires an additional instrument because the exit status of the firm is endogenous to the error term as well. I estimate propensity score for exit at the firm level and include it into the set of instruments for equation (4.16). I model the propensity score for each firm using average national exit rate in its own industry excluding own location, and lagged characteristics of the firm, such as wages, size and age indicators. In section 5.2 I show that propensity score, constructed in this way, is a strong predictor of exit at the firm level. The intuition behind this instrument is similar to Bartik shocks, and the same identification requirements apply.

5 Estimation of Labor Demand Elasticity

In this section, I take the model to the data. I estimate the model with the General Method of Moments (GMM), using the sample of manufacturing firms in Brazil in 1997-2010, who are 1 year and older and have 5 and more employees. I first describe the estimation sample in detail, and then introduce the estimation equation and the necessary parametrization. After that, I show that the instruments outlined in section 4 have power. Finally, I describe the estimation results. I find that a one standard deviation increase in labor market tightness reduces employment growth by 1.7 percentage points, while a one standard deviation increase in wages reduces employment growth by 3.1 percentage points in a median firm in a median region. Furthermore, my results demonstrate that the differences in labor demand elasticity *across* regions are larges than the differences in labor demand elasticity *within* regions. For instance, a median firm in a microregion at the 10th percentile reduces employment growth by 1.2 p.p. in response to a one standard deviation increase in labor market tightness and by 1.6 p.p. in response to a one standard deviation increase in wages, while a median firm in a microregion at the 90th percentile reduces employment growth by 2.5 p.p. in response to a one standard deviation increase in labor market tightness and by 6.3 p.p. in response to a one standard deviation increase in wages.

5.1 Estimation sample

To estimate the model, I assemble a firm-level sample on manufacturing firms in Brazil in 1997-2010 based on the data from the employer-employee matched dataset. Beside the sample on firms, I build a sample of average net employment growth and average wage change at the industry–microregion level, which are used to construct the Bartik instruments and the control variable.

Firms. I focus on manufacturing firms only, which allows me to treat the goods which firms are producing as tradable and abstract from the effect of local multipliers.[11] Furthermore, I analyze the employment growth in the firms which are 1 year and older thus abstracting from the firm entry as well. Next, I use CNAE 1995 3 digit industry classification code, which corresponds to the ISIC Rev. 3 international classification at the 2-digit level, and contains 104 manufacturing industries.[12] Under this classification, firms producing food and beverages are distinguished from apparel manufacturing, and, for example, sugar mills, and coffee roasting and grinding are considered different groups of activity.

I define a firm as a single-establishment productive unit (i.e.a plant), which operates in one location. Though the data allows me to distinguish between single establishment and multi-establishment firms, I use a narrow definition of a firm so that the local market where the firm hires its workers is well-defined. However, to ensure that none of the results are driven by the multi establishment nature of a firm, I include controls for a multi establishment firm in all estimation equations.

[11] My estimation approach can be extended to include local goods by modeling local prices explicitly. However, after allowing for local goods, Bartik instrument for wage growth no longer satisfies the exclusion restriction, and thus estimation will have to be based solely on the minimum wage instrument.

[12] Complete list of industries can be found at www.cnae.ibge.gov.br (in Portuguese). I exclude from my analysis industry "Production of nuclear fuels" (CNAE code 233), which employs about 7,000 people annually, but is concentrated in a single location.

I study manufacturing firms 1 year and older, who reside in microregions with at least 20 active firms in manufacturing. This restriction leaves me with 1,714,648 firm-year observations on 337,366 firms in 331 microregions. An average firm is 8.6 years old, has 39 employees, pays 4.26 reals per hour in 2005 prices (approx. \$1.87 in 2005), employs 0.19% of workers of its industry in its own microregion (table 5) and faces 3,500 manufacturing firms competing with it for workers in the same microregion.

The firm sample is constructed in three steps. First, I obtain information on the total employment in a firm in December of each year. Second, I estimate the average wage of a 35 year old male production worker with a high school degree and zero tenure at each firm. Using the standard Mincer-style regressions (see appendix A for regression results), I take away the wage premium associated with workers' tenure, gender, age, education, and occupation and use the average residualized logarithm of the real wages per hour as a measure of firm's wage level. This procedure allows me to abstract from differences in workforce composition across firms. Lastly, I calculate firm's age using the year when the firm was first observed as the year of entry. Since the data spans back to 1986, I truncate the age at 10 years and consider all firms older than 10 years old as one age group.

I focus on two measures of growth at the firm level: net employment growth rate and the change in average log wages. I calculate the net employment growth rate using the mid-year firm size (see Davis and Haltiwanger, 1992), which allows me to keep exiting firms in the sample:

$$NEG_{ijlt} = \frac{E_{ijlt} - E_{ijl,t-1}}{0.5\left(E_{ijl,t-1} + E_{ijl,t}\right)}, \tag{5.1}$$

where E_{jilt} is the size of the firm i in industry j and microregion l in year t. This measure has several desirable features. First, it is bounded between -2 and 2. Second, it allows to account for firm exit and entry, though only exit will be considered in this paper. And finally, net employment growth is a transformation of the traditional growth rate $NEG_{ijlt} = 2\left(E_{ijlt}/E_{ijl,t-1} - 1\right)/\left(E_{ijlt}/E_{ijl,t-1} + 1\right)$ and is numerically close to the log points of employment growth for the small rates of growth.

Wage changes can only be calculated for firms who have some employees both in $t-1$ and t, and thus is only available for surviving firms. On average, 2.5% firms exit every year, and the change in wages is observed for 1,671,542 firm-year observations (table 5). For surviving firms, I obtain the wage change as follows:

$$\Delta w_{ijlt} = w_{ijlt} - w_{ijl,t-1}, \tag{5.2}$$

where w_{ijlt} is the average log wage at the firm i after having taken away the effect of the workforce composition.

Though RAIS is an administrative dataset, it is not uncommon for a firm record to be missing for some years. In fact, about 16% of the establishments which are present in a given year have a missing record for the previous year. As a result, both employment growth and wage growth are not observed for such firms as well. I deal with the problem of missing records in the following ways. First, I use longitudinal information on firms to identify entry and exit. That is, I treat a firm-year observation as an entry only if it is the year when this firm appears in the data for the first time. Similarly, I treat a firm-year observation as an exit if it is the year when this firm appears in the data for the last time. This procedure reduces misattributing a missing record to entry/exit. Second, I include in the estimation sample either firms which are present in two consecutive years, or firms for whom an exit was recorded. Labor demand elasticity estimates using this sample would be consistent if firm-specific shocks are orthogonal to firm's steady-state productivity and hiring advantage, which determine its size and wages.

Industry – microregion. I estimate the average net employment growth at the industry–microregion level, denoted by NEG_{jlt}, as the fixed effects in the regression of the firm level net employment growth on the full set of lagged age indicators and an indicator for a lagged multi-establishment firm:

$$NEG_{ijlt} = \sum_k \alpha_{1,k}\, age_{kijl,t-1} + \alpha_2\, multiest_{ijl,t-1} + NEG_{jlt} + \nu_{ijlt}. \tag{5.3}$$

This procedure allows me to compare employment growth across microregions controlling for the age composition of microregions. Since young and mature firms grow at different rates (Haltiwanger et al., 2013), microregions regions with younger firms would tend to grow faster, and taking away the effect of firm age ensures that the variation in Bartik shocks is not driven by the difference in firm composition across regions. I obtain the average wage change at the industry–microregion level in a similar way by regressing the firm wage change on the age controls, indicator for a multi-establishment firm and industry–microregion–year fixed effects:

$$\Delta w_{ijlt} = \sum_k \beta_{1,k}\, age_{kijl,t-1} + \beta_2\, multiest_{ijl,t-1} + \Delta w_{jlt} + u_{ijlt}. \tag{5.4}$$

The average log wage at the industry–microregion–year level is estimated in the same way. In addition, all regressions are weighted by the lagged firm size.

5.2 First stage and preliminary results

First stage. Following the discussion in section 4, I use four types of instruments. I instrument for changes in labor market tightness with the Bartik shocks in employment. I instrument for wage changes at the firm level with Bartik shocks in wages and the share of the firm's workforce paid less than next year's minimum wage. Finally, I instrument for the exit of the firm with the propensity score for exit estimated using a logistic regression.

All instruments perform well in the first stage (tables 7–8). However, the regression of the change in labor market tightness measured by probability to find a job on Bartik instrument in employment has a low F-statistics for the instrument (4.14). For this reason, I use labor market tightness measured by employment tot population ratio in my preferred specification. Next, the propensity score is a strong predictor of the exit status as well (table 8) Finally, though the coefficients at both the Bartik shock in wages in wages and exposure to minimum wage shock are significant, exposure to minimum wages is a much more powerful instrument than the Bartik shock, as the Bartik shock varies only across region–year observations, but not across firms in the same region–year. The control variable for the industry demand shocks is significant and has the same coefficients in all specifications (table 9). The coefficients at the instrument variables also remain stable across specifications and are not sensitive to including control variable in the first stage regression.

Reduced form results. Before taking the model to the data, I compare OLS and IV estimates of firms' response to changes in labor demand conditions. For exploratory purposes, I first estimate a model on the sample of surviving firms only, which is subject to selection bias due to entry. I fit the following specification:

$$\begin{aligned} NEG_{ijlt} = {} & (\beta_1 + \beta_2 w_{ijl,t-1})\Delta \log \psi_{lt} + (\beta_3 + \beta_4 w_{ijl,t-1})\Delta w_{ijlt} \\ & + (\beta_5 + \beta_6 w_{ijl,t-1})\Delta w_{ijlt}\, \widehat{\mathrm{d}p}_{jlt} \\ & + \beta_{7,k}\, age_{kijl,t-1} + \beta_8\, multiest_{ijl,t-1} + \beta_{9,t} + \beta_{10,t}\Sigma_{l,00} + \varepsilon_{ijlt}, \end{aligned} \tag{5.5}$$

where $\Sigma_{l,00}$ is the share of manufacturing workers employed by the formal sector in the microregion in 2000, obtained from the 2000 Census.

Table 10 presents the results of this specification. As expected, OLS yields the biased estimate of firms' response to labor market conditions: both coefficients at the change in tightness and change in wages are positive. This is a result of two identification problems discussed above: correlation between the demand shocks and the changes in labor market conditions, and selection into surviving firms. Furthermore, IV estimation on the sample of surviving firms also yields a positive coefficient for both elasticities if elasticity of labor demand is allowed to vary across firms, suggesting that selection problem into exiting firm is severe in this case.

Next, I estimate a reduced form specification of the model using the sample with both surviving and exiting firms:

$$\begin{aligned} NEG_{ijlt} = {} & (\beta_1 + \beta_2 w_{ijl,t-1})\Delta \log \psi_{lt} + (\beta_3 + \beta_4 w_{ijl,t-1})\Delta w_{ijlt} \\ & + (\beta_5 + \beta_6 w_{ijl,t-1})\Delta w_{ijlt}\, \widehat{\mathrm{d}p}_{jlt} \\ & + (\beta_7 + \beta_8 w_{ijl,t-1})\tilde{\psi}_{lt}(w_{ijl,t-1} - w_{1jl,t-1})\mathbb{1}\{exit_{ijlt}\} \\ & + (\beta_9 + \beta_{10} w_{ijl,t-1})(\widehat{\mathrm{d}p}_{jlt} - \widehat{\mathrm{d}p}_{1,jlt})\mathbb{1}\{exit_{ijlt}\} \\ & + \beta_{11,k}\, age_{kijl,t-1} + \beta_1 2\, multiest_{ijl,t-1} \\ & + \beta_{13,t} + \beta_{14,t}\Sigma_{l,00} + \beta_{15,t}\mathbb{1}\{exit_{ijlt}\} + \varepsilon_{ijlt}, \end{aligned} \tag{5.6}$$

Table 11 presents the results, omitting coefficients $\beta_7 - \beta_1 5$ for the clarity of exposition. For this estimation, I have used the wage change at a reference firm as the wage change for exiting firms. After correcting for selection, IV estimation yields a negative sign for labor demand elasticity with respect to wages and for the change in labor market tightness. These results suggest that controlling for selection into surviving firms is essential to eliminate the bias in the estimates of firm sensitivity in response to wage changes. In addition, these exploratory regressions show that the weak instrument problem is unlikely, because both specifications demonstrate high values of Craig-Donald statistic.

5.3 Estimation method

I estimate labor demand elasticities using the General Method of Moments (GMM), using the following estimation equation:

$$\begin{aligned} NEG_{ijlt} = {} & X_{1,ijl,t-1}\Gamma + \mu_{0,t} + \mu_{1,t}\Sigma_{l,00} \\ & - \alpha_{ijl}\Delta \log \psi_{lt} \\ & - \Omega_{ijl}\ \Delta w_{ijlt}\ \mathbb{1}\{survival_{ijlt}\} + \Omega_{ijl}\ \Delta w_{1,jlt}\ \mathbb{1}\{exit_{ijlt}\} \\ & + \Omega_{ijl}\big(\gamma_{0,lt} + \gamma_{1,l}\ \tilde{\psi}_{lt}(w_{ijl,t-1} - w_{1jl,t-1})\big)\mathbb{1}\{exit_{ijlt}\} \\ & + \Omega_{ijl}\big(\gamma_{2,l}(\widehat{\mathrm{d}p}_{jlt} - \widehat{\mathrm{d}p}_{1,jlt})\big)\mathbb{1}\{exit_{ijlt}\} \\ & + \Omega_{ijl}\big(\lambda_{0,lt} + \lambda_{1,l}\ \widehat{\mathrm{d}p}_{jlt}\big) + u'''_{ijlt}, \end{aligned} \tag{5.7}$$

where $\Sigma_{l,00}$ is the share of the formal employment in total manufacturing employment in microregion l in 2000, calculated using the data from the 2000 Census.

In addition to the effect of the change in the labor market conditions and control variable for the industry demand shocks, I include two sets of controls. First, I allow for a nationwide annual shocks to employment growth and region-specific employment growth due to the increase of the formal sector. The first control is implemented by including the full set of year indicators in the estimation equation, and the second control is implemented by interacting the share of the formal sector in manufacturing employment with year indicator variables. These controls ensure that the results are not driven by the wave of formalization which occurred in the 2000s. Finally, I include a full set of indicators for lagged age of the firm and an indicator for a lagged multi establishment status of the firm (variables contained in $X_{1,ijl,t-1}$), since it is known that young and mature firms grow at different rates (Haltiwanger et al., 2013).

Parametrization. I have shown in the section 3.2 that the elasticities of labor demand α_{ijl} and Ω_{ijl} can be expressed as functions of the firm wage and microregion specific parameters:

$$\alpha_{ijlt} = a_{0,l} + \frac{1}{a_{1,l} + a_{2,l}w_{ijl,t-1}}, \tag{5.8}$$

$$\Omega_{ijlt} = \frac{1}{\beta_{1,l} + \beta_{2,l}w_{ijl,t-1}}. \tag{5.9}$$

This representation does not have any industry-specific parameters because each firm in a microregion l pays the same share of its surplus as wages. This parametrization arises in the model with perfect mobility across sectors, as the outside options of the workers do not depend on the industry, where a worker was previously employed.

To reduce the number of parameters to be estimated, I parametrize coefficients $a_{0,l}$, $a_{1,l}$ and $a_{2,l}$, and $\beta_{1,l}$ and $\beta_{2,l}$ using observable characteristics of a microregion. Steady-state coefficients $a_{0,l}$ and $a_{2,l}$, and $\beta_{2,l}$ vary with the steady-state level of the labor market tightness of the microregion, and coefficients $a_{1,l}$ and $\beta_{1,l}$ depend on the average potential wage in the microregion as well. Guided by these observations, I parametrize $a_{0,l}$, $a_{2,l}$, and $\beta_{2,l}$ using the size of the formal sector in manufacturing in the microregion in 2000 and the total employment (formal and informal) to population ratio in 2000. Both these variables are obtained from the 2000 Census. In a similar way, I parametrize the coefficients $a_{1,l}$ and $\beta_{1,l}$ using the same two variables and an average wage premium paid by the formal sector in the microregion relative to the rest of the country. Finally, I allow the incidental parameters for the exit $\gamma_{0,lt}$ and $\gamma_{1,l}$, and the incidental parameters of the control variable $\lambda_{0,lt}$ and $\lambda_{1,l}$ depend on the size of the formal sector in manufacturing and the total employment to population ratio in 2000.

As a result, I am estimating six sets of parameters:

(1) coefficients at the controls δ;

(2) parameters of nationwide shocks $\mu_{0,t}$ and formalization trend $\mu_{1,t}$;

(3) parameters of the labor demand elasticity with respect to the change in labor market tightness:

$$a_{0,l} = \left(Z_l \pi^{a_0}\right)^{-1}, \tag{5.10}$$

$$a_{1,l} = Z_l^w \, \pi^{a_1}, \tag{5.11}$$

$$a_{2,l} = Z_l \, \pi^{a_2}, \tag{5.12}$$

where Z_l contains a constant, size of the formal sector in manufacturing in 2000 and total employment to population ratio in 2000, and Z_l^w contains a constant, size of the formal sector in manufacturing, total employment to population ratio and average regional wage premium.[13]

(4) parameters of the labor demand elasticity with respect to the wage change:

$$\beta_{1,l} = Z_l^w \, \pi^{\beta_1}, \tag{5.13}$$

$$\beta_{2,l} = Z_l \, \pi^{\beta_2}. \tag{5.14}$$

[13] Both the share of the formal sector in manufacturing and total employment to population ratio are calculates using the data from 2000 Census. Average regional wage premium is calculated using the data from RAIS.

(5) parameters associated with the firm exit:

$$\gamma_{0,lt} = Z_l\, \pi_t^{\gamma_0}, \tag{5.15}$$

$$\gamma_{1,l} = Z_l\, \pi^{\gamma_1}, \tag{5.16}$$

$$\gamma_{2,l} = Z_l\, \pi^{\gamma_2}. \tag{5.17}$$

(6) parameters associated with the control variable:

$$\lambda_{0,lt} = Z_l\, \pi_t^{\lambda_0}, \tag{5.18}$$

$$\lambda_{1,l} = Z_l\, \pi^{\lambda_1}. \tag{5.19}$$

I estimate the model using the general method of moments with an identity weighting matrix. Following the discussion in the section 4, I instrument the estimation equation (5.7) with Bartik instruments for employment and wage change, as well as with the minimum wage instrument. I include the control variable and the propensity score for exit into the set of instruments as well. In addition, since $\mathbb{E}[u'_{ijlt}] = 0$ and due to the assumption that neither the idiosyncratic shocks $\mathrm{d}\varepsilon_{it}$ and $\tilde{\xi}_{it}$, nor the location shock $\mathrm{d}\zeta_{lt}$ are correlated with the wage level $w_{jil,t-1}$, I also use a constant and the level of wages $w_{ijl,t-1}$ as instruments. Finally, I add all the variables in $X_{ijl,t-1}$, Z_l and Z_L^w to the set of instruments, and interact wages with all of the instruments mentioned above.

5.4 Results and goodness of fit

I start presenting results by discussing the magnitude of the estimated labor demand elasticities. Complete estimates of the structural parameters can be found in the tables 23–26 of the appendix. Figure 9 presents the estimated elasticity of labor demand for firms which pay median wages in each microregion. To be able to compare the estimates of the elasticity between the two margins, I have scaled the change in wage and the change in labor market tightness by their respective standard deviations.[14] A median firm in a median microregion reduces its employment growth by 3.1 percentage points in response to a one standard deviation increase in wages, and by 1.7 percentage points in response to a one standard deviation increase in labor market tightness This response is relatively small: a one standard deviation change in labor market conditions along each margin induces the change in employment growth which smaller than 10% of a one standard deviation in employment growth across firms. Furthermore, a two standard deviations increase in both labor market tightness and wages is required for a median firm to destroy one job. On average, a median firm growth 0% and employes 12 workers.

All firms generally are more sensitive to changes in wages rather than changes in labor market tightness. A median firm responds almost twice as strongly to a one standard deviation increase in

[14] Standard deviations were calculated for the estimation sample of firms during the whole period of observation, so firms in two different microregions are exposed to a change in labor market conditions of the same size.

wages compared to a one standard deviation increase in labor market tightness. This relationship holds across all microregions, with the exception of the regions with a very small size of the formal sector in manufacturing (figure 10). In regions where more than 60% of manufacturing workers are hired by the formal sector, elasticity with respect to change in wages can be five times as high as elasticity with respect to changes in labor market tightness. However, the estimates suggest that in the regions with the share of formal sector below 30% firms respond stronger to changes in labor market tightness rather than wages. This result is likely to be driven by measurement error. The measurement error in wages is bigger for the firms in less formal microregions, because these firms themselves are smaller and the regions have fewer observations as well. As a result, the estimate of the elasticity with respect to wage changes suffers from the attenuation bias in these microregions. The estimate of the elasticity with respect to change in labor market tightness is likely to be biased in these microregions as well. Since my measure of the change in labor market tightness does not capture the changes in demand in the informal sector, I will be overestimating firms' response to changes in labor market tightness, if demand in the informal sector is positively correlated with demand in the formal sector.

Microregions with a larger formal sector in manufacturing are more sensitive to changes in wages both in relative and in absolute terms. Figure 9 plots the estimated labor demand elasticities in a median-paying firm in each microregion as a function of the size of the formal sector in this microregion in 2000. In the regions where the formal sector employed less than 60% of workers in manufacturing in 2000, labor demand elasticity with respect to wage change ranges between 1% and 5%, while in the regions with a higher share of the formal sector labor demand elasticity is higher as well 510%. Labor demand elasticity with respect to changes in labor market tightness varies much less across regions and is around 1-2%. Next, the size of the formal sector in a microregion plays much bigger role in the magnitude of labor demand elasticity than employment to population ratio or microregion wage premium (figures 11 and 12).

Interestingly, the differences in labor demand elasticities within microregions are much smaller than between microregions. With the few exceptions, firms at the 10th percentile of wage distribution within the region have similar sensitivity to labor market conditions as firms at the 90th percentile of wage distribution (figures 13a and 13b).

Finally, the model fits the data well. Figure 8 plots the average observed employment growth across firms and employment growth predicted by the model. Generally, the model fits the growth in large firms better, than employment growth at the small firms. This is an expected outcome which results from the weighting strategy. Since I expect smaller firms to have higher measurement error in wages, I weight the observations with the lagged firm size.

6 The Role of Labor Market Conditions in Employment Fluctuations across Regions

In this section, I connect firm level elasticity of labor demand to regional employment growth. First, I show that regional employment regional employment growth can de decomposed into employment growth due to changes in in labor market conditions in the region and employment growth due to changes in revenue and costs of hiring across firms. Using this decomposition, I demonstrate that changes in labor market conditions reduce the variance of employment growth over the business cycle by 20% in a median microregion. Next, I discuss the contributions of changes in labor market tightness and changes in wages. I show that despite large firm level sensitivity to changes in wages rather than changes in labor market tightness, changes in labor market conditions along each margin contribute equally to the overall effect of labor market conditions. Finally, I demonstrate that the differential effect of labor market conditions across regions is caused by the heterogeneity in the change in labor market conditions themselves rather than by differences in labor demand elasticities across regions. Using the stylized facts outlined in section 2, I argue that the rapid growth of the national minimum wages in Brazil in 1997-2010 generated heterogeneous effects of labor market conditions on employment growth across regions. In particular, I document that microregions with higher exposure to minimum wage increase experienced smaller stabilizing effect of the change in labor market conditions during local recessions and larger diminishing effect of the change in labor market conditions during local expansions.

Variance decomposition. I start by decomposing firm level employment growth into the contribution of labor market conditions and changes in revenue and hiring costs. Using the same notation as in the empirical equation (5.7), I can rewrite employment growth at the firm level as follows:

$$
\begin{aligned}
NEG_{ijlt} &= \Delta\text{Labor market conditions}_{ijlt} + \text{Shock}_{ijlt}, && (6.1)\\
\Delta\text{Labor market conditions}_{ijlt} &= \text{Response to } \Delta\log\psi_{ijlt} + \text{Response to } \Delta w_{ijlt} && (6.2)\\
\text{Response to } \Delta\log\psi_{ijlt} &= -\hat{\alpha}_{ijl}\Delta\log\psi_{lt} && (6.3)\\
\text{Response to } \Delta w_{ijlt} &= -\hat{\Omega}_{ijl}\,\Delta w_{ijlt}\,\mathbb{1}\{survival_{ijlt}\} - \hat{\Omega}_{ijl}\,\Delta w_{1jlt}\,\mathbb{1}\{exit_{ijlt}\} \\
&\quad + \hat{\Omega}_{ijl}\big(\hat{\gamma}_{0,lt} + \hat{\gamma}_{1,l}\,\Delta\log\psi_{lt}(w_{ijl,t-1} - w_{1jl,t-1})\big)\mathbb{1}\{exit_{ijlt}\}, && (6.4)\\
\text{Shock}_{ijlt} &= X_{ijl,t-1}\hat{\Gamma} + \hat{\mu}_{0,t} + \hat{\mu}_{1,t}\Sigma_{l,00} - \hat{\Omega}_{ijl}\big(\hat{\lambda}_{0,lt} + \hat{\lambda}_{1,l}\,\widehat{\mathrm{d}p}_{jlt}\big) \\
&\quad + \hat{\gamma}_{2,l}\,(\widehat{\mathrm{d}p}_{jlt} - \widehat{\mathrm{d}p}_{1lt})\mathbb{1}\{exit_{ijlt}\} + \hat{u}'''_{ijlt}. && (6.5)
\end{aligned}
$$

In this decomposition, I am primarily interested in the role of labor market conditions in employment growth. For this reason, I combine all the other shifters of employment growth together and take them as given. Hereafter, I will refer to these shifters as “shocks”. These shocks include firm’s life-cycle growth changes, firm level changes in revenue or cost of hiring, region level shocks to regional revenue advantage, nationwide demand changes in each industry or trends in national labor demand.

I attribute to the contribution of the changes in labor market conditions employment growth which was caused either by changes in labor market tightness $\Delta \log \psi_{lt}$, or by changes in wages at the firm level Δw_{ijlt}. As a result, the absence of changes in labor market conditions is equivalent to a thought experiment in which 1) any changes in demand for labor in the region are exactly offset by migration, so that formal employment in manufacturing to population ratio remains the same; 2) firm level wages respond neither to the firm level changes in revenue, nor to the changes in the outside option of the workers. Thus, this decomposition does not distinguish the two possible reasons of the firm level wage growth: changes in firm's own revenue, and changes in the prevailing wage level in a microregion. For that reason, this decomposition is a conservative estimate of the contribution of labor market conditions to employment growth – it can be interpreted as a lower bound, because it underestimates employment growth which would have occurred in the absence of the changes in labor market conditions.

The decomposition of employment growth at the firm level (6.1) can be aggregated at the regional level:

$$NEG_{lt} = \Delta\text{Labor market conditions}_{lt} + \text{Shock}_{lt}, \tag{6.6}$$

$$\begin{aligned}\Delta\text{Labor market conditions}_{lt} &= \sum_i s_{il,t-1} \text{ Response to } \Delta \log \psi_{ijlt} \\ &+ \sum_i s_{il,t-1} \text{ Response to } \Delta w_{ijlt},\end{aligned} \tag{6.7}$$

$$\text{Shock}_{lt} = \sum_i s_{il,t-1} \text{ Shocks}_{ijlt}, \tag{6.8}$$

where $s_{il,t-1} = E_{ijl,t-1} \big/ E_{l,t-1}$ is the share of each firm in total formal employment in manufacturing in its region. Thus, regional shocks are a composition of industry shocks given the microregion's industrial composition, regional idiosyncratic shocks and firm idiosyncratic shocks. Similarly, the contribution of labor market conditions at the regional level arises from the individual firm response to these changes.

I use this regional decomposition to study the role of labor market conditions in the variance of employment growth over the business cycle. I compare two scenarios: the observed employment growth, and the hypothetical employment growth which would arise of the labor market conditions did not change over the business cycle. Thus, for each microregion I compare the variance of employment growth $\text{Var}\left(NEG_{lt}\right)$ with the variance of shocks $\text{Var}\left(\text{Shock}_{lt}\right)$. Table 12 presents the results of this exercise. The results show that changes in labor market conditions diminish employment fluctuations over the business cycle by 20%. That is, the variance of employment growth in the case of no changes in labor market conditions would have been 120% of the observed variance of the employment growth. Furthermore, this result is not likely to be driven by the measurement error in the microregions with smaller number of observations. In particular, the magnitude is very similar among the microregions where the share of the formal sector in manufacturing was higher than 50% in 2000.

Average effect of labor market conditions. This estimate suggests that labor market conditions play an important role in employment fluctuations over the business cycle. How big is this counter-cyclical effect of labor market conditions on employment growth? Table 13 compares the observed annual employment growth with the employment growth under the scenario of no change in labor market conditions. It considers two cases: positive regional shocks Shock_{lt} and negative regional shocks Shock_{lt}. If there was no change in labor market tightness or wages, an average microregion would have grown almost 3 percentage points more (55% of observed growth) when the labor demand shock was positive, and declined 0.4 percentage points less (5% of observed employment decline, table 13). Thus, the effect of the change in labor market conditions on employment growth in Brazil over 1997-2010 was asymmetric: changes in labor market conditions reduced employment growth during expansions but failed to stabilize employment growth during recessions.

This asymmetry holds for all microregions. Table 14 shows results of the regression of growth due to labor market conditions on the estimated regional shock. It demonstrates the same asymmetric pattern. The effect of the change of labor market conditions is counter-cyclical: a one percentage point shock is associated with 0.13 percentage point effect of labor market conditions, but if the shock is negative, this effect is smaller: only 0.05 percentage points. In addition, all microregions experience the negative effect of changes in labor market conditions over the whole period of observation, even when the shock is negative.

These results are mirrored by the patterns of correlation between the growth due to change in labor market tightness and regional shock (table 15a and 15b). Thus, the asymmetry of the effect of labor market conditions is also driven by the fact that labor market tightness in the region is growing even when the manufacturing sector is experiencing a negative shock. This is likely to be the case because the non-manufacturing sector of the local economy is growing even when manufacturing is declining.

Contribution of change in tightness vs. change in wages. Having documented that changes in labor market conditions lead to counter-cyclical employment growth, I turn to the question of which margin drives this effect: change in labor market tightness or change in wages. I decompose the variance of the employment growth due to labor market conditions into contribution of each margin in the following way:

$$\begin{aligned}\mathrm{Var}(\Delta\text{Labor market conditions}_{ijlt}) = {} & \mathrm{Var}(\text{ Response to } \Delta \log \psi) \\ & + \mathrm{Var}(\text{ Response to } \Delta w) \\ & + 2\,\mathrm{Cov}(\text{ Response to } \Delta \log \psi,\ \text{Response to } \Delta w). \qquad (6.9)\end{aligned}$$

Table 17 presents the results of this decomposition. Among all the regions 80% of the effect of the change in labor market conditions is driven by change in labor market tightness, while among the regions where formal sector employed more than 50% of workers in manufacturing changes in labor market tightness explained 55% of variance in labor market conditions. These differences are driven by fact that microregions with a higher share of the formal sector in manufacturing are more sensitive to wage changes than less formal microregions. Table 18 presents the contribution of the change in labor market tightness and change in wages to the overall effect of labor market conditions in a hypothetical scenario when all regions have the same labor demand elasticities. These results clearly show, that changes in labor market tightness would have explained 70% of the variation in the effect of labor market conditions in the microregions with a higher share of the formal sector if these regions were less sensitive to the changes in wages.

Finally, even though all firms in all microregions respond stronger to changes in wages rather than changes in labor market tightness, changes in wages drive only 30% to 50% of the overall effect of labor market conditions. This evidence goes in line with the stylized facts outlined in the section 2, which demonstrated that wage growth across regions was driven both by increases in the national minimum wage as well as by local business cycles.

Minimum wages. Both the evidence on the diminished variance of employment growth over the business cycle and on the differential contribution of each margin to the overall effect of labor market conditions suggest that there is substantial heterogeneity in the effect of labor market conditions across regions. Moreover, this heterogeneity is driven by differential changes in labor market conditions across regions rather than by the differences in labor demand demand elasticities between regions. Figure 14 plots the observed employment growth across regions and the hypothetical employment growth under the scenario of homogenous labor demand elasticities, fixed at the average elasticity across regions.

What drives the cyclicality of labor market conditions? Section 2 established that both labor market tightness and wages respond to local business cycles, but in microregions which are more exposed to increase in national minimum wage, wages are growing more independently of local business cycles. In this subsection, I explore how much regional exposure to minimum wage increases affect the effect of labor market conditions.

Tables 19a and 19b present the average effect of labor market conditions for regions with low (0-7% of workforce in the last year would not have met this year minimum wage requirements), medium (7-20% of workforce would not have met the minimum wage requirements) and very high (more than 20% of workforce would not have met the minimum wage requirements) exposure to the minimum wage increase. Microregions with all three levels of exposure were observed in each year during 1997-2010, even when the minimum wage was declining in real terms (figure 7). The average effect of changes if wages varied substantially with the exposure to the minimum wage increase. During local recessions, microregions with the low or medium exposure experienced a counter-cyclical effect of the wage changes. On the other hand, wages in the highly exposed microregions were growing, thus failing to produce stabilizing effect on employment growth. However, during local expansions, higher exposure to minimum wage had the opposite effect on the role of labor market conditions in employment growth. Both microregions with medium and high exposure to minimum wage experienced large counter-cyclical effect of change in wages, which reduced employment growth in these regions. At the same time, employment growth in the microregions with low exposure to minimum wage increase was, in fact, stimulated by reduction in real wages. These patterns were observed both among microregions with smaller and larger share of the formal sector in manufacturing, and were not driven by the differences in labor demand elasticity across regions (tables 20a and 20b). Thus, microregions with higher exposure to minimum wage increase experienced smaller stabilizing effect of the change in labor market conditions during local recessions and larger diminishing effect of the change in labor market conditions during local expansions.

7 Conclusion

In this paper, I study how much changes in labor market conditions affect employment growth across firms and reduce employment fluctuations over the business cycle. I build a search and bargaining model of a local labor market with heterogeneous firms and estimate labor demand elasticities at the firm level using an employer-employee matched dataset from Brazil. To my knowledge, I am the first paper to estimate labor demand response to changing labor market conditions over the business cycle.

I consider two margins of adjustment: changes in labor market tightness and changes in wages. I find that all firms are more sensitive to changes in wages rather than labor market tightness, and there is substantial heterogeneity in labor demand elasticity across regions.

I use these estimates to analyze the contribution of labor market conditions to employment growth at the regional level. I quantify how different employment growth would have been if labor market conditions remained the same over the business cycle, but regional economies experienced the same changes in consumer demand and productivity. I find that changes in labor market conditions reduce the variance of employment growth by 20% in a median region, this effect is equally driven by changes in labor market tightness and changes in wages.

Finall,y I argue that the rapid growth of the national minimum wages in Brazil in 1997-2010 generated heterogeneous effects of labor market conditions on employment growth across regions. In particular, I document that microregions with higher exposure to minimum wage increase experienced smaller stabilizing effect of the change in labor market conditions during local recessions and larger diminishing effect of the change in labor market conditions during local expansions. These results demonstrate that economic policy can have a substantial impact on the labor market adjustment and volatility of employment over the business cycle.

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8 Tables

Table 1. Employment growth in the informal and formal sectors, at the state level, 2001-2009.

Variable	Dependent variable:			
	(1)	(2)	(3)	(4)
	Δ Log informal empl.	Δ Log self-empl.	Δ Log total empl.	Δ Unempl. rate
Δ Log formal empl.	0.04	0.059	0.39^{***}	-0.059^{***}
	(0.089)	(0.12)	(0.05)	(0.017)
Year FE	X	X	X	X
Obs	216	216	216	216
R^2	0.27	0.064	0.35	0.46

Weighted with the lagged state size s.e. clustered at the year level in parentheses.
Source: PNAD. Sample: 27 states, 2001-2009. All regressions include year fixed effects.

Table 2. Changes in labor market tightness and growth of the GDP per capita across microregions, 2000-2010. Labor market tightness measured by employment to population ratio.

Variable	Dependent variable: $\Delta \log \psi_{lt}$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \log$ GDP per capita	0.2***	0.19***	0.19***	0.19***	0.19***	0.2***
	(0.047)	(0.047)	(0.045)	(0.045)	(0.046)	(0.062)
$\Delta \log$ GDP per capita×Exposure to min wage change: 7-20%						−0.068
						(0.083)
$\Delta \log$ GDP per capita×Exposure to min wage change: 20-90%						0.018
						(0.076)
Exposure to min wage change: 7-20%					0.0043	0.0063
					(0.005)	(0.0049)
Exposure to min wage change: 20-90%					0.015***	0.015***
					(0.0051)	(0.0053)
Share formal in mfg		−0.023		−0.0061		
		(0.015)		(0.021)		
Log total emp to pop ratio		0.012		0.0023		
		(0.025)		(0.022)		
Average wage prem			−0.0093	−0.0085		
			(0.0068)	(0.0082)		
Year FE	X	X	X	X	X	X
Obs	3,606	3,606	3,606	3,606	3,606	3,606
R^2	0.52	0.52	0.53	0.53	0.53	0.53

Weighted with the lagged microregion size. Robust s.e. in parentheses. Sample: RAIS, 331 microregions with 20 and more manufacturing firms. 2000-2010. $\Delta \log$ GDP per capita is the growth rate of GDP per capita at the microregion level. "Share formal in mfg" is the share of the formal sector in manufacturing employment in 2000. "Log total emp to pop ratio" is the logarithm of the ratio of the total (formal and informal) employment to population ratio in 2000. "Average wage prem" is the average wage premium paid by the formal sector manufacturing firms relative to the rest of the country. "Exposure to minimum wage change" is percentage of workforce in a microregion directly exposed to minimum wage change, 0-7% is the omitted group.

Table 3. Changes in labor market tightness and growth of the GDP per capita across microregions, 2000-2010. Labor market tightness measure by probability to find a job.

Variable	Dependent variable: $\Delta \log \psi_{lt}$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \log$ GDP per capita	0.4^{***}	0.41^{***}	0.43^{***}	0.43^{***}	0.41^{***}	0.46^{***}
	(0.1)	(0.096)	(0.097)	(0.093)	(0.1)	(0.13)
$\Delta \log$ GDP per capita×Exposure to min wage change: 7-20%						-0.23^{***}
						(0.13)
$\Delta \log$ GDP per capita×Exposure to min wage change: 20-90%						−0.068
						(0.15)
Exposure to min wage change: 7-20%					−0.0035	0.0033
					(0.0066)	(0.0077)
Exposure to min wage change: 20-90%					−0.013	−0.011
					(0.01)	(0.012)
Share formal in mfg		0.032		−0.032		
		(0.026)		(0.036)		
Log total emp to pop ratio		−0.05		−0.013		
		(0.038)		(0.034)		
Average wage prem			0.028^{***}	0.032^{***}		
			(0.012)	(0.015)		
Year FE	X	X	X	X	X	X
Obs	3,606	3,606	3,606	3,606	3,606	3,606
R^2	0.58	0.58	0.59	0.59	0.58	0.58

Weighted with the lagged microregion size. Robust s.e. in parentheses. Sample: RAIS, 331 microregions with 20 and more manufacturing firms. 2000-2010. $\Delta \log$ GDP per capita is the growth rate of GDP per capita at the microregion level. "Share formal in mfg" is the share of the formal sector in manufacturing employment in 2000. "Log total emp to pop ratio" is the logarithm of the ratio of the total (formal and informal) employment to population ratio in 2000. "Average wage prem" is the average wage premium paid by the formal sector manufacturing firms relative to the rest of the country. "Exposure to minimum wage change" is percentage of workforce in a microregion directly exposed to minimum wage change, 0-7% is the omitted group.

Table 4. Changes in wages and growth of the GDP per capita across microregions, 2000-2010.

Variable	Dependent variable: Average Δw_{ijlt}					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \log$ GDP per capita	0.085^{***}	0.083^{***}	0.064^{***}	0.065^{***}	0.075^{***}	0.1^{***}
	(0.022)	(0.02)	(0.02)	(0.02)	(0.022)	(0.026)
$\Delta \log$ GDP per capita×Exposure to min wage change: 7-20%						-0.091^{***}
						(0.034)
$\Delta \log$ GDP per capita×Exposure to min wage change: 20-90%						-0.1^{***}
						(0.049)
Exposure to min wage change: 7-20%					0.0096^{***}	0.012^{***}
					(0.0022)	(0.0022)
Exposure to min wage change: 20-90%					0.012^{***}	0.014^{***}
					(0.0047)	(0.004)
Share formal in mfg		-0.045^{***}		-0.0053		
		(0.0081)		(0.01)		
Log total emp to pop ratio		0.056^{***}		0.033^{***}		
		(0.011)		(0.011)		
Average wage prem			-0.021^{***}	-0.02^{***}		
			(0.0035)	(0.004)		
Year FE	X	X	X	X	X	X
Obs	3,606	3,606	3,606	3,606	3,606	3,606
R^2	0.79	0.81	0.82	0.82	0.8	0.8

Weighted with the lagged microregion size. Robust s.e. in parentheses. Sample: RAIS, 331 microregions with 20 and more manufacturing firms. 2000-2010. $\Delta \log$ GDP per capita is the growth rate of GDP per capita at the microregion level. "Share formal in mfg" is the share of the formal sector in manufacturing employment in 2000. "Log total emp to pop ratio" is the logarithm of the ratio of the total (formal and informal) employment to population ratio in 2000. "Average wage prem" is the average wage premium paid by the formal sector manufacturing firms relative to the rest of the country. "Exposure to minimum wage change" is percentage of workforce in a microregion directly exposed to minimum wage change, 0-7% is the omitted group.

Table 5. Summary statistics for the estimation sample: firms.

	Mean	Sd	Min	25th p-tile	Median	75th p-tile	Max
Lagged size	39	170	5	7	12	26	23506
Lagged log wage	1.5	0.41	−1.671	1.17	1.4	1.7	6.18
Lagged age	8.6	6.2	0	3	8	13	23
Share paid min wage	0.066	0.19	0	0	0	0.0017	1
Share exposed to min wage change	0.12	0.26	0	0	0	0.095	1
NEG	−0.092	0.5	−2	−0.2222	0	0.15	1.99
Exit	0.025	0.16	0	0	0	0	1
Wage change	0.0005	0.18	−4.263	−0.0834	−0.0013	0.082	4.68
Change in log formal emp in mfg to pop ratio	0.02	0.071	−0.9153	−0.01929	0.018	0.057	1.09
No. of rivals at microregion	3500	5300	19	345	920	4200	18329
No. of rivals at industry-microregion	210	510	0	11	44	160	3673
Lagged % of employment in microreg.	0.27	1.3	0.00067	0.0087	0.04	0.14	89.18
Lagged % of employment in industry-microreg.	0.19	0.97	0.00062	0.0076	0.033	0.11	86.46

No firm-year obs.: 1,714,648

No of firm-year obs. with observed wage change: 1,671,542

No firms: 337,366

Source: RAIS and Censo demográfico 2000. Manufacturing firms 1 year and older with 5 and more workers active in 331 microregions with 20 and more manufacturing firms, 1997-2010.

Table 6. Summary statistics for the estimation sample: microregions.

	Mean	Sd	Min	25th p-tile	Median	75th p-tile	Max
Microregion in 2000							
Share formal in mfg	0.51	0.17	0.062	0.38	0.53	0.64	0.86
Share formal	0.33	0.12	0.055	0.22	0.33	0.42	0.62
Share of manufacturing	0.13	0.064	0.035	0.082	0.11	0.15	0.47
Population, thsds	459.31	1000	25.45	137.63	224.33	395.42	12788.97
Log emp to pop ratio	−0.9333	0.13	−1.441	−1.027	−0.9135	−0.8496	−0.533
Av. regional wage premium	−1.404	0.24	−1.917	−1.579	−1.408	−1.256	−0.5717
Mean lagged firm variables							
Age	7.84	1.2	4.09	7.04	7.85	8.72	10.73
Size	40.87	69	11.11	23.86	30.79	40.66	1073
Log wage	1.26	0.21	0.84	1.1	1.26	1.4	1.85
Exposure to minimum wage							
Share paid min wage	0.11	0.11	0.0043	0.035	0.069	0.15	0.66
Share exposed to min wage change	0.18	0.15	0.0059	0.063	0.13	0.25	0.75
Average changes in labor market conditions							
Av. wage change	0.0048	0.013	−0.04693	−0.003925	0.0057	0.013	0.053
Change in log formal emp in mfg to pop ratio	0.035	0.034	−0.1266	0.012	0.03	0.053	0.25
Average no. firms per year							
No firms in microreg.	372.11	1100	23.75	63.92	143.43	331.93	16166.07
No firms in industry-microreg.	35.01	69	2.54	8.41	16.23	32.48	949.11

No microregions: 331

Source: RAIS and Censo demográfico 2000. 331 microregions with 20 and more manufacturing firms, 1997-2010.

Table 7. First stage for change in labor market tightness using Bartik instrument in employment.

Variable	Dependent variable: Change in labor market tightness measured by	
	(1)	(2)
	Emp to pop ratio	Prob to find a job
$\widehat{NEG}_{lt}$	0.2***	0.26***
	(0.037)	(0.13)
Year FE	X	X
Year MMC controls	X	X
Obs	4,545	4,545
R^2	0.2	0.069
IV F-stat.	29.85	4.14
P-value	0	0.06

Weighted with the lagged employment in the microregion. Robust s.e. in parentheses. Sample: RAIS, 331 microregions with more than 20 manufacturing firms 1 year and older, 1997-2010. $\widehat{NEG}_{lt}$ is a Bartik instrument in employment.

Table 8. First stage for firm's exit using propensity score for exit, calculated with the average rate of exit of firms in the same industry in other microregions and firm's characteristics.

Variable	Dependent variable: Indicator for exit at the firm level
	(1)
Propensity score for exit	0.38***
	(0.043)
Age controls	X
Year FE	X
Year MMC controls	X
Obs	1,714,648
R^2	0.009
IV F-stat.	78.85
P-value	0

Weighted with lagged firm size. S.e. clustered at the industry–year level in parentheses. Sample: RAIS, manufacturing firms 1 year and older active in 337 microregions with 2 firms in the same industry. 1997-2010. All regression include full set of indicators for lagged firm age and lagged firm multi-establishment status, year fixed effects.

Table 9. First stage for wage change at the firm level using minimum wage and Bartik instruments

Variable	Dependent variable: Change in the log wage at the firm level				
	(1)	(2)	(3)	(4)	(5)
Exposure to min wage change	0.12^{***}		0.12^{***}		0.12^{***}
	(0.0047)		(0.0047)		(0.0048)
$\widehat{\mathrm{d}w}_{lt}$		0.15^{***}	0.13^{***}	0.14^{***}	0.12^{***}
		(0.047)	(0.047)	(0.046)	(0.045)
$\widehat{\mathrm{d}p}_{jlt}$				0.049^{***}	0.053^{***}
				(0.022)	(0.021)
Age controls	X	X	X	X	X
Year FE	X	X	X	X	X
Year MMC controls	X	X	X	X	X
Obs	1,671,542	1,671,542	1,671,542	1,671,542	1,671,542
R^2	0.054	0.041	0.055	0.042	0.055
IV F-stat.	638	9.78	328	9.69	317
P-value	0	0	0	0	0

Firm level regressions weighted with lagged firm size, S.e. clustered at the industry–year level in parentheses.

Sample: RAIS, manufacturing firms 1 year and older with 5 and more workers, active in 331 microregions with 20 and more manufacturing firms. 1997-2010. "Exposure to min wage change" is the share of employees in year $t-1$ paid below the minimum wage level in t. $\widehat{\mathrm{d}w}_{lt}$ is Bartik instrument in wages. $\widehat{\mathrm{d}p}_{jlt}$ is the control variable for the nationwide industry shock. All regression include full set of indicators for lagged firm age and lagged firm multi-establishment status, year fixed effects. "Year MMC controls" stand for share of formal sector in manufacturing in 2000 interacted with year indicators.

Table 10. Reduced form results of the effect of labor market conditions on job creation. Labor market tightness is measured as formal employment to population ratio. Surviving firms.

Variable	Dependent variable: Net employment growth at the firm level			
	(1) OLS	(2) IV	(3) OLS	(4) IV
$\Delta \log \psi_{lt}$	0.4^{***}	3.3^{***}	-0.26^{***}	0.74
	(0.042)	(0.43)	(0.096)	(0.67)
$\Delta \log \psi_{lt} \times w_{ijl,t-1}$			0.44^{***}	0.67^{***}
			(0.056)	(0.36)
Δw_{ijlt}	0.0055^{***}	-0.18^{***}	0.013^{***}	0.02
	(0.0021)	(0.017)	(0.0042)	(0.02)
$\Delta w_{ijlt} \times w_{ijl,t-1}$			-0.0019	0.039^{***}
			(0.0021)	(0.019)
$\widehat{\mathrm{d}p}_{jlt}$	0.061	0.092	0.23^{***}	0.52^{***}
	(0.05)	(0.06)	(0.055)	(0.12)
$\widehat{\mathrm{d}p}_{jlt} \times w_{ijl,t-1}$			-0.089^{***}	-0.27^{***}
			(0.016)	(0.072)
Age controls	X	X	X	X
Year FE	X	X	X	X
Year MMC controls	X	X	X	X
Obs	1,671,542	1,671,542	1,671,542	1,671,542
R^2	0.016	-0.3	0.018	-0.048
Anderson Stat.		117		49.46
Craig-Donald Stat.		5,039		1,125

S.e. clustered at the industry-year level in parentheses. Weighted with the lagged firm size. Sample: RAIS, *surviving* firms in manufacturing 1 year and older with at least 5 employees, active in 331 microregions with more than 20 firms. 1997-2010. All regressions include full set of indicators for lagged firm age and lagged firm multi-establishment status, as well as year fixed effects. $\Delta \log \psi_{lt}$ and Δw_{ijlt} are scaled to represent a change of 1 s.d. $\Delta \log \psi_{lt}$ is the change in labor market tightness, Δw_{ijlt} is the change in wages at the firm level, $\widehat{\mathrm{d}p}_{jlt}$ is control variable for industry demand shock. $w_{ijl,t-1}$ is lagged log wage at the firm.

Table 11. Reduced form results of the effect of labor market conditions on job creation. Labor market tightness is measured as formal employment to population ratio. Surviving firms.

Variable	Dependent variable: Net employment growth at the firm level			
	(1) OLS	(2) IV	(3) OLS	(4) IV
$\Delta \log \psi_{lt}$	0.39^{***}	2.1^{***}	-0.26^{***}	-0.068
	(0.042)	(0.55)	(0.095)	(0.48)
$\Delta \log \psi_{lt} \times w_{ijl,t-1}$			0.43^{***}	1.5^{***}
			(0.055)	(0.21)
Δw_{ijlt}	0.0055^{***}	-0.15^{***}	0.013^{***}	-0.0083
	(0.0021)	(0.018)	(0.0042)	(0.016)
$\Delta w_{ijlt} \times w_{ijl,t-1}$			-0.0019	0.00076
			(0.0021)	(0.0087)
$\widehat{\mathrm{d}p}_{jlt}$	0.06	0.065	0.22^{***}	0.077
	(0.049)	(0.064)	(0.055)	(0.083)
$\widehat{\mathrm{d}p}_{jlt} \times w_{ijl,t-1}$			-0.087^{***}	-0.029
			(0.015)	(0.036)
Age controls	X	X	X	X
Year FE	X	X	X	X
Year MMC controls	X	X	X	X
Year Exit FE	X	X	X	X
Exit parameters	X	X	X	X
Obs	1,714,648	1,714,648	1,714,648	1,714,648
R^2	0.38	0.051	0.38	0.32
Anderson Stat.		53.22		139
Craig-Donald Stat.		45.61		93.71

S.e. clustered at the industry-year level in parentheses. Weighted with the lagged firm size. Sample: RAIS, *all* firms in manufacturing 1 year and older with at least 5 employees, active in 331 microregions with more than 20 firms. 1997-2010. All regression include full set of indicators for lagged firm age and lagged firm multi-establishment status, as well as year fixed effects and year fixed effects interacted with exit status. Exit parameters are the part of estimation equation associated with exit. See text for details. $\Delta \log \psi_{lt}$ and Δw_{ijlt} are scaled to represent a change of 1 s.d. $\Delta \log \psi_{lt}$ is the change in labor market tigtness, Δw_{ijlt} is the change in wages at the firm level, $\widehat{\mathrm{d}p}_{jlt}$ is control variable for industry demand shock. $w_{ijl,t-1}$ is lagged log wage at the firm.

Table 12. Variance decomposition of employment fluctuations within microregions, % of observed variance.

	All regions	Formal regions
25 percentile	109.93	112.41
Median	124.29	125.91
75 percentile	141.59	146.12

Ratio of variance of employment growth under no changes in labor market conditions to the observed variance of employment growth. Based on GMM estimates of labor demand elasticities. Sample: 331 microregions with 20 and more manufacturing firms (all regions) and 189 microregions with the share of formal sector in manufacturing in 2000 larger than 50% (formal regions), 1997-2010.

Table 13. Impact of response to labor market conditions on employment growth across microregions.

(a) All microregions.

	Negative shock	Positive shock
Observed growth		
Observed growth	−8.58	5.38
Growth due to:		
Δlabor market conditions	−0.44	−2.93
Δtightness	−0.64	−2.76
Δwages	0.21	−0.17
% of observed growth due to:		
Δlabor market conditions	5.08	−54.45
Δtightness	7.5	−51.28
Δwages	−2.42	−3.17

(b) Microregions with the share of formal sector in manufacturing larger than 50% in 2000.

	Negative shock	Positive shock
Observed growth		
Observed growth	−7.28	5.01
Growth due to:		
Δlabor market conditions	0.09	−2.06
Δtightness	−0.3	−1.86
Δwages	0.39	−0.2
% of observed growth due to:		
Δlabor market conditions	−1.27	−41.15
Δtightness	4.09	−37.17
Δwages	−5.36	−3.98

Table 14. Growth due to change in labor market conditions and regional shock.

Variable	Dependent variable: Growth due to Δlabor market conditions			
	(1) All regions	(2) All regions	(3) Formal regions	(4) Formal regions
Intercept	-0.013^{***}	-0.012^{***}	-0.0085^{***}	-0.012^{***}
	(0.00039)	(0.0013)	(0.00043)	(0.0012)
Indicator for Negative Shock$_{lt}$		0.0083^{***}		0.011^{***}
		(0.0015)		(0.0016)
Shock$_{lt}$	-0.13^{***}	-0.16^{***}	-0.12^{***}	-0.099^{***}
	(0.007)	(0.019)	(0.0083)	(0.019)
Shock$_{lt}\times$Indicator for Negative Shock$_{lt}$		0.11^{***}		0.044^{***}
		(0.022)		(0.024)
Obs	4,545	4,545	2,626	2,626
R^2	0.21	0.24	0.22	0.25

Weighted with the lagged microregion size. Robust s.e. in parentheses. Sample: 331 microregions with 20 and more manufacturing firms (all microregions) or 189 microregions with 20 and more manufacturing firms and share of formal employment in manufacturing in 2000 large than 50% (formal microregions), 1997-2010. Shock$_{lt}$ is the regional shock calculated based on the GMM estimations of labor demand elasticity.

Table 15. Cyclicality of the effect of change in labor market tightness.

(a) Growth due to change in labor market tightness and regional shock.

Variable	Dependent variable: Growth due to Δlabor market tightness			
	(1) All regions	(2) All regions	(3) Formal regions	(4) Formal regions
Intercept	-0.013^{***}	-0.011^{***}	-0.01^{***}	-0.011^{***}
	(0.00029)	(0.0011)	(0.00028)	(0.0007)
Indicator for Negative Shock$_{lt}$		0.0043^{***}		0.0064^{***}
		(0.0012)		(0.00086)
Shock$_{lt}$	-0.11^{***}	-0.15^{***}	-0.086^{***}	-0.088^{***}
	(0.0055)	(0.016)	(0.0045)	(0.01)
Shock$_{lt}$ $\times$Indicator for Negative Shock$_{lt}$		0.11^{***}		0.048^{***}
		(0.017)		(0.012)
Obs	4,545	4,545	2,626	2,626
R^2	0.21	0.25	0.26	0.29

Weighted with the lagged microregion size. Robust s.e. in parentheses. Sample: 331 microregions with 20 and more manufacturing firms (all microregions) or 189 microregions with 20 and more manufacturing firms and share of formal employment in manufacturing in 2000 large than 50% (formal microregions), 1997-2010. Shock$_{lt}$ is the regional shock calculated based on the GMM estimations of labor demand elasticity.

(b) Change in labor market tightness and regional shock.

Variable	Dependent variable: Δlabor market tightness			
	(1) All regions	(2) All regions	(3) Formal regions	(4) Formal regions
Intercept	0.036^{***}	0.038^{***}	0.032^{***}	0.037^{***}
	(0.00079)	(0.0021)	(0.0009)	(0.0022)
Indicator for Negative Shock$_{lt}$		-0.018^{***}		-0.021^{***}
		(0.0026)		(0.0028)
Shock$_{lt}$	0.27^{***}	0.32^{***}	0.28^{***}	0.28^{***}
	(0.012)	(0.028)	(0.015)	(0.032)
Shock$_{lt}$ $\times$Indicator for Negative Shock$_{lt}$		-0.2^{***}		-0.15^{***}
		(0.033)		(0.038)
Obs	4,545	4,545	2,626	2,626
R^2	0.25	0.28	0.27	0.3

Weighted with the lagged microregion size. Robust s.e. in parentheses. Sample: 331 microregions with 20 and more manufacturing firms (all microregions) or 189 microregions with 20 and more manufacturing firms and share of formal employment in manufacturing in 2000 large than 50% (formal microregions), 1997-2010. Shock$_{lt}$ is the regional shock calculated based on the GMM estimations of labor demand elasticity.

Table 16. Cyclicality of the effect of change in wages.

(a) Growth due to change in wages and regional shock.

Variable	Dependent variable: Growth due to Δwages			
	(1) All regions	(2) All regions	(3) Formal regions	(4) Formal regions
Intercept	0.00086^{***}	-0.001^{***}	0.0014^{***}	-0.00085
	(0.00025)	(0.00058)	(0.00032)	(0.00095)
Indicator for Negative Shock_{lt}		0.004^{***}		0.0045^{***}
		(0.00084)		(0.0013)
Shock_{lt}	-0.019^{***}	-0.0063	-0.03^{***}	-0.011
	(0.0038)	(0.0083)	(0.0062)	(0.016)
$\text{Shock}_{lt} \times$Indicator for Negative Shock_{lt}		0.000012		-0.0042
		(0.011)		(0.02)
Obs	4,545	4,545	2,626	2,626
R^2	0.02	0.03	0.031	0.041

Weighted with the lagged microregion size. Robust s.e. in parentheses. Sample: 331 microregions with 20 and more manufacturing firms (all microregions) or 189 microregions with 20 and more manufacturing firms and share of formal employment in manufacturing in 2000 large than 50% (formal microregions), 1997-2010. Shock_{lt} is the regional shock calculated based on the GMM estimations of labor demand elasticity.

(b) Average change in wages and regional shock.

Variable	Dependent variable: Average Δwages			
	(1) All regions	(2) All regions	(3) Formal regions	(4) Formal regions
Intercept	0.00074	0.006^{***}	-0.0018^{***}	0.0036
	(0.00088)	(0.0017)	(0.0011)	(0.0024)
Indicator for Negative Shock_{lt}		-0.013^{***}		-0.014^{***}
		(0.0026)		(0.0034)
Shock_{lt}	0.085^{***}	0.056^{***}	0.12^{***}	0.086^{***}
	(0.011)	(0.021)	(0.016)	(0.036)
$\text{Shock}_{lt} \times$Indicator for Negative Shock_{lt}		-0.028		-0.035
		(0.03)		(0.046)
Obs	4,545	4,545	2,626	2,626
R^2	0.029	0.038	0.048	0.058

Weighted with the lagged microregion size. Robust s.e. in parentheses. Sample: 331 microregions with 20 and more manufacturing firms (all microregions) or 189 microregions with 20 and more manufacturing firms and share of formal employment in manufacturing in 2000 large than 50% (formal microregions), 1997-2010. Shock_{lt} is the regional shock calculated based on the GMM estimations of labor demand elasticity.

Table 17. Variance decomposition of the employment growth due to changes in labor market conditions.

	All regions	Formal regions
Variance of growth due to:		
Δlabor market conditions	100	100
Δlabor market tightness	81.44	51.24
Δwages	16	45.47
2 Covariance between growth due to:		
Δlabor market conditions and Δwages	2.56	3.29

Ratio of variance of employment growth due to changes along each margin to the variance of employment growth due to change in labor market conditions. Based on GMM estimates of labor demand elasticities. Sample: 331 microregions with 20 and more manufacturing firms (all regions) and 189 microregions with the share of formal sector in manufacturing in 2000 larger than 50% (formal regions), 1997-2010.

Table 18. Variance decomposition of the employment growth due to changes in labor market conditions. Hypothetical case when all regions have the same labor demand elasticity

	All regions	Formal regions
Variance of growth due to:		
Δlabor market conditions	100	100
Δlabor market tightness	77.47	73.42
Δwages	18.98	23.11
2 Covariance between growth due to:		
Δlabor market conditions and Δwages	3.54	3.48

Ratio of variance of employment growth due to changes along each margin to the variance of employment growth due to change in labor market conditions. Based on GMM estimates of labor demand elasticities. Sample: 331 microregions with 20 and more manufacturing firms (all regions) and 189 microregions with the share of formal sector in manufacturing in 2000 larger than 50% (formal regions), 1997-2010.

Table 19. Differential effect of labor market conditions by region exposure to minimum wage increase.

(a) All microregions.

	Positive shock			Negative shock		
	0-7%	7-20%	20-90%	0-7%	7-20%	20-90%
Observed growth						
Observed growth	−7.1	−8.8	−9.97	4.95	5.74	5.42
Growth due to:						
Δlabor market conditions	0.47	−0.63	−1.23	−1.76	−2.96	−3.9
Δtightness	−0.14	−0.75	−1.09	−1.84	−2.72	−3.58
Δwages	0.61	0.12	−0.14	0.08	−0.24	−0.32
% of observed growth due to:						
Δlabor market conditions	−6.65	7.19	12.32	−35.49	−51.59	−71.93
Δtightness	1.92	8.52	10.92	−37.15	−47.38	−66.03
Δwages	−8.57	−1.33	1.4	1.67	−4.2	−5.9

(b) Microregions with the share of formal sector in manufacturing larger than 50% in 2000.

	Positive shock			Negative shock		
	0-7%	7-20%	20-90%	0-7%	7-20%	20-90%
Observed growth						
Observed growth	−6.82	−7.48	−8.36	4.87	5.1	5.2
Growth due to:						
Δlabor market conditions	0.56	−0.26	−0.67	−1.66	−2.34	−2.54
Δtightness	−0.1	−0.46	−0.59	−1.75	−1.99	−1.89
Δwages	0.66	0.21	−0.08	0.09	−0.35	−0.64
% of observed growth due to:						
Δlabor market conditions	−8.26	3.41	8.02	−34.13	−45.92	−48.78
Δtightness	1.42	6.19	7.01	−36.03	−39	−36.4
Δwages	−9.68	−2.78	1.02	1.9	−6.91	−12.38

Table 20. Observed and hypothetical effect of labor market conditions by region exposure to minimum wage increase, the case of the same labor demand elasticity across regions.

(a) All microregions.

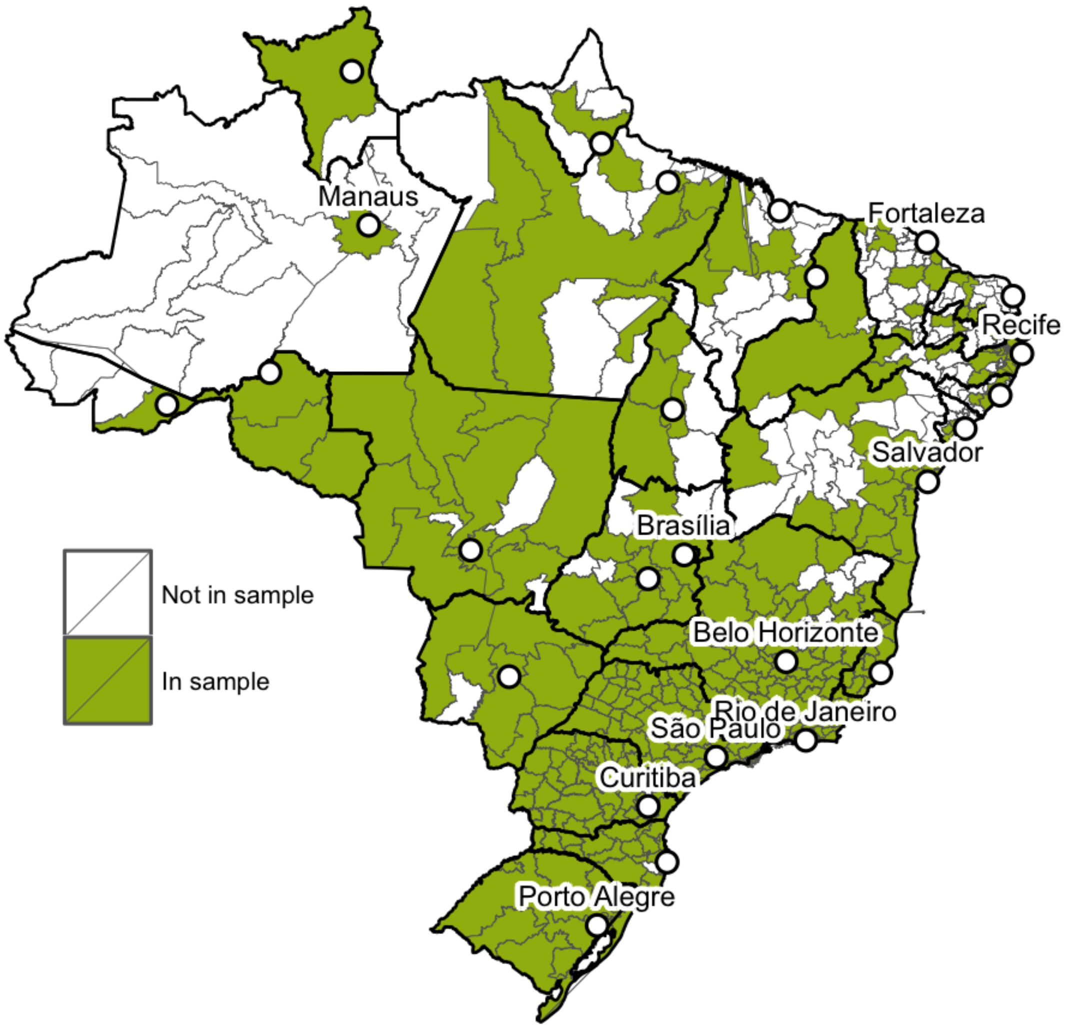
	Positive shock			Negative shock		
	0-7%	7-20%	20-90%	0-7%	7-20%	20-90%
Observed growth						
Observed growth	−7.1	−8.8	−9.97	4.95	5.74	5.42
Observed growth due to:						
Δlabor market conditions	0.47	−0.63	−1.23	−1.76	−2.96	−3.9
Δtightness	−0.14	−0.75	−1.09	−1.84	−2.72	−3.58
Δwages	0.61	0.12	−0.14	0.08	−0.24	−0.32
Hypothetical growth due to:						
Δlabor market conditions	0.38	−0.54	−1.08	−2.03	−2.84	−3.27
Δtightness	−0.14	−0.72	−0.92	−2.14	−2.67	−2.87
Δwages	0.52	0.18	−0.16	0.1	−0.17	−0.39

(b) Microregions with the share of formal sector in manufacturing larger than 50% in 2000.

	Positive shock			Negative shock		
	0-7%	7-20%	20-90%	0-7%	7-20%	20-90%
Observed growth						
Observed growth	−6.82	−7.48	−8.36	4.87	5.1	5.2
Observed growth due to:						
Δlabor market conditions	0.56	−0.26	−0.67	−1.66	−2.34	−2.54
Δtightness	−0.1	−0.46	−0.59	−1.75	−1.99	−1.89
Δwages	0.66	0.21	−0.08	0.09	−0.35	−0.64
Hypothetical growth due to:						
Δlabor market conditions	0.41	−0.29	−0.7	−2.01	−2.62	−2.77
Δtightness	−0.11	−0.52	−0.67	−2.11	−2.38	−2.26
Δwages	0.51	0.23	−0.03	0.1	−0.25	−0.51

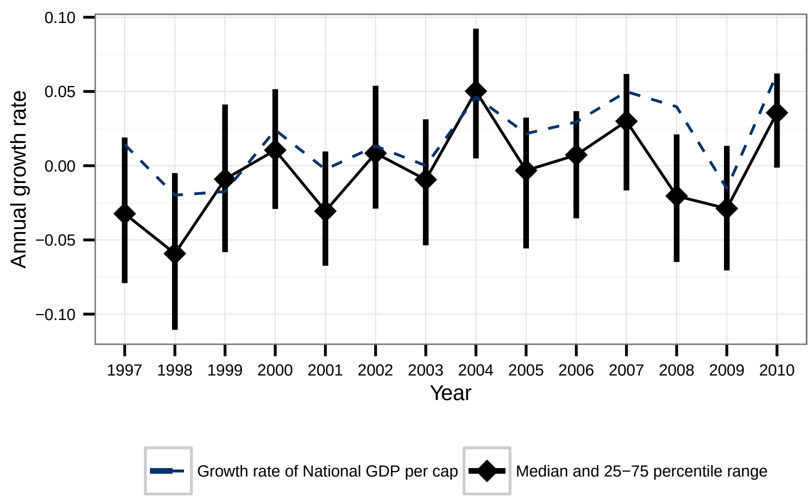
9 Figures

Figure 1. Microregions used in the estimation.



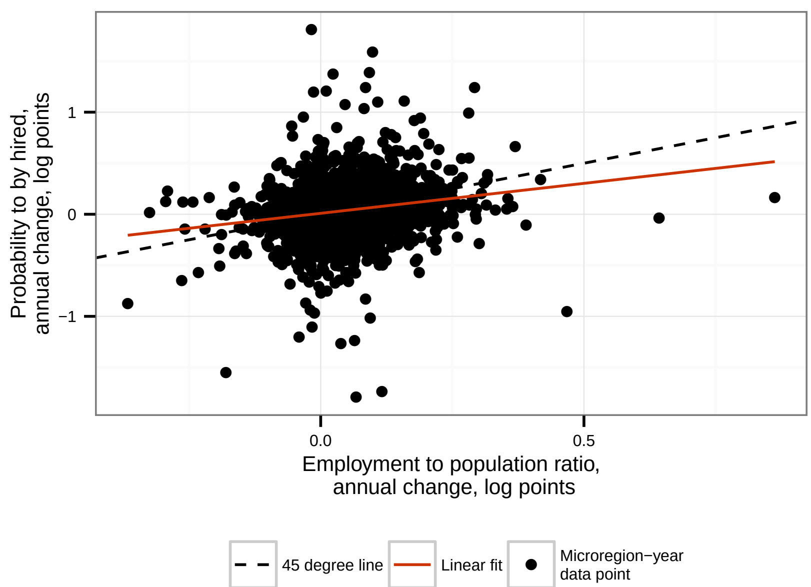
Consistent microregion boundaries over 1991-2010. State capitals displayed, largest 10 cities labelled. Thicker lines represent state boundaries. Estimation sample uses microregions with 20 and more active manufacturing firms for at least 10 years during 1997-2010.

Figure 2. Distribution of net employment growth across microregions, 1997-2010. Existing firms in manufacturing with 5 and more workers.



Source: RAIS, IPEA.

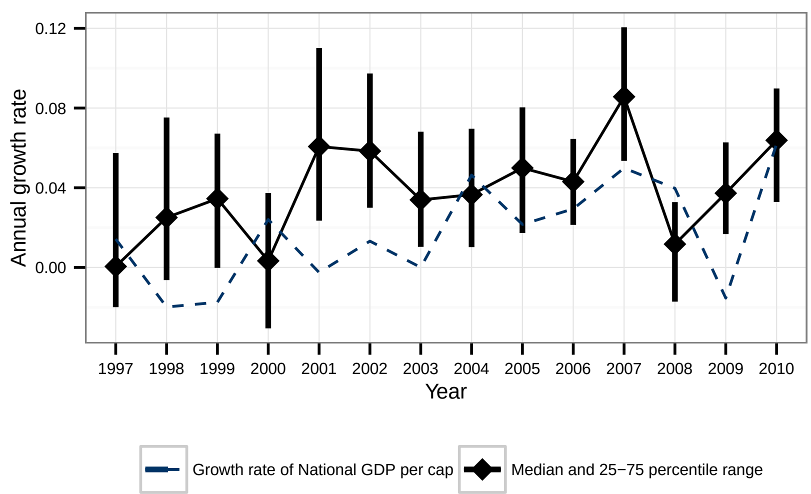
Figure 3. Correlation between the two measures of changes in labor market tightness: change in probability to be hired and change in employment to population ratio. 1997-2010.



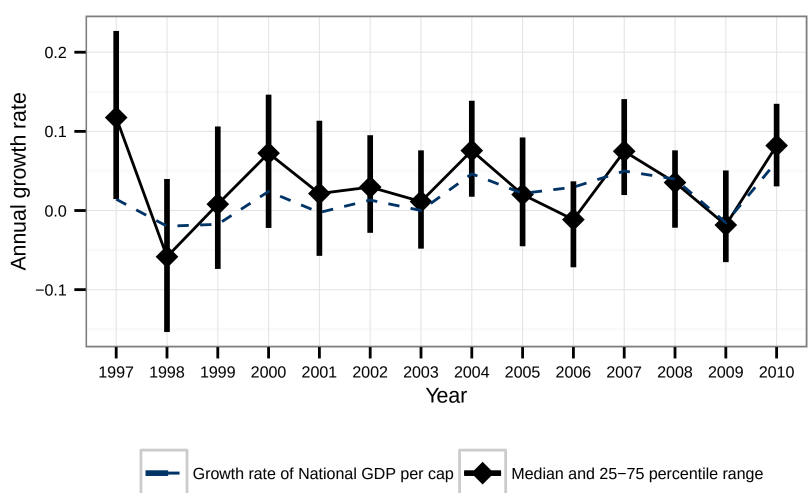
Each point is a microregion-year observation. Source: RAIS, IPEA.

Figure 4. Distribution of changes in labor market tightness across microregions, 1997-2010.

(a) Labor market tightness measured by log employment to population ratio.

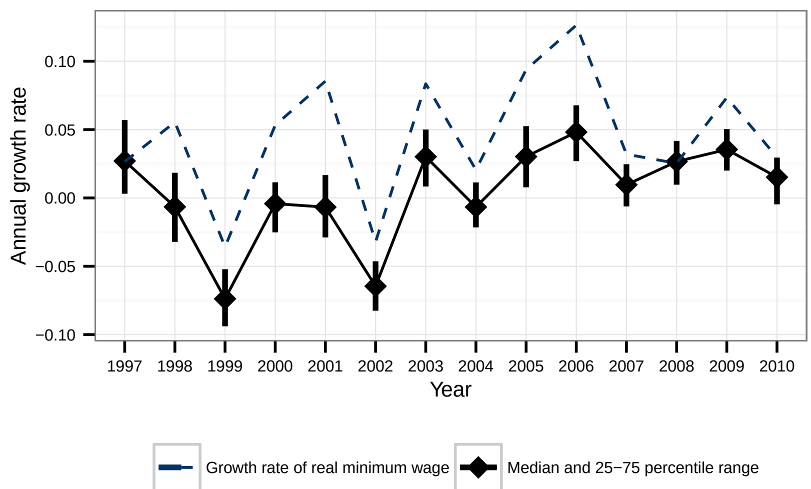


(b) Labor market tightness measured by probability to be hired if separated from a job in the current or past year.



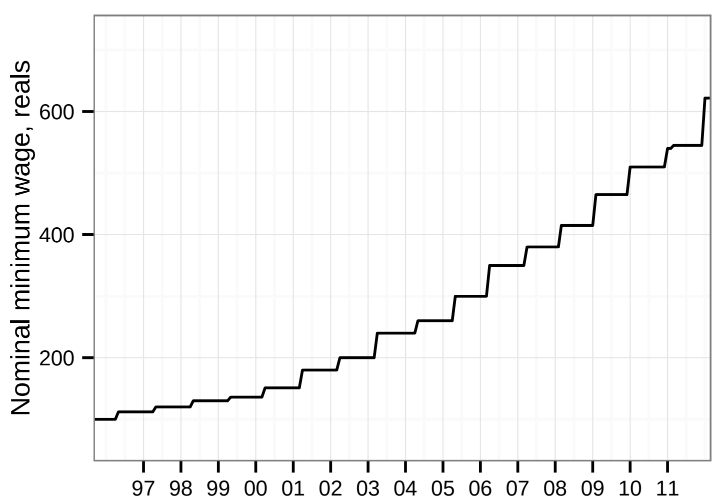
Source: RAIS, IPEA.

Figure 5. Distribution of changes in wages across microregions, 1997-2010.



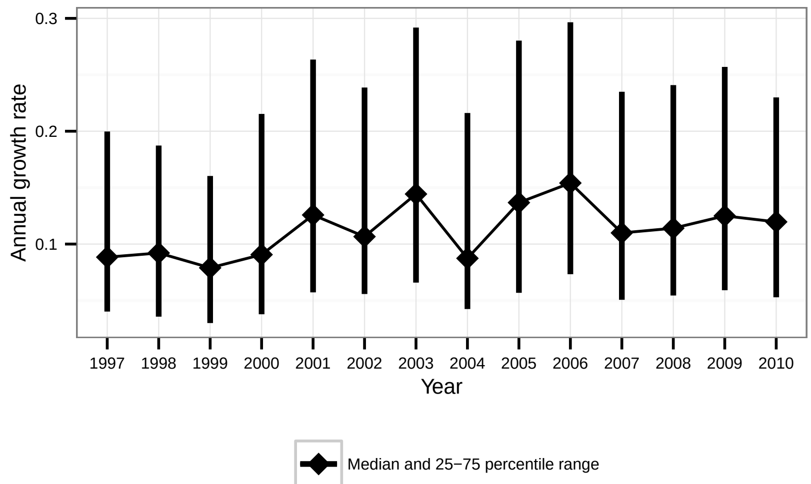
Source: RAIS, IPEA and Brazilian Ministry of Labor.
Wages is measured as the mean of the logarithm of real hourly wages for a fixed demographic group. All prices are in $R 2005.

Figure 6. Minimum wage, Brazil, 1997-2010.



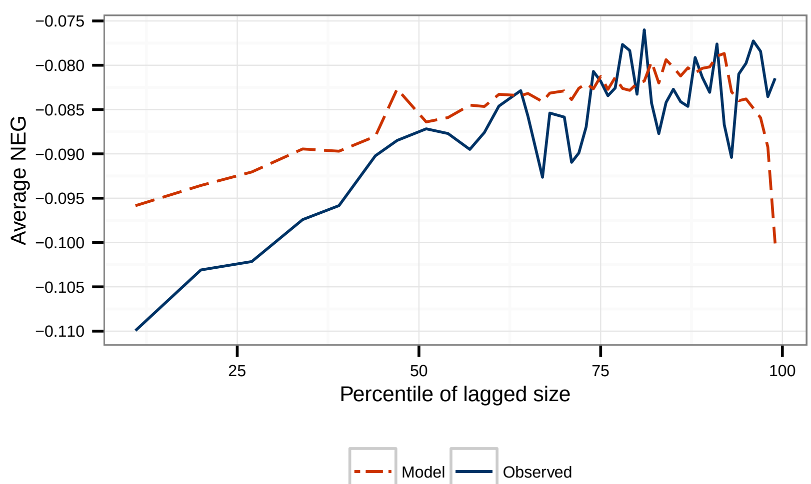
Nominal monthly national minimum wage. Source: Brazilian Ministry of Labor.

Figure 7. Distribution of exposure to minimum wage increase across microregions, 1997-2010.



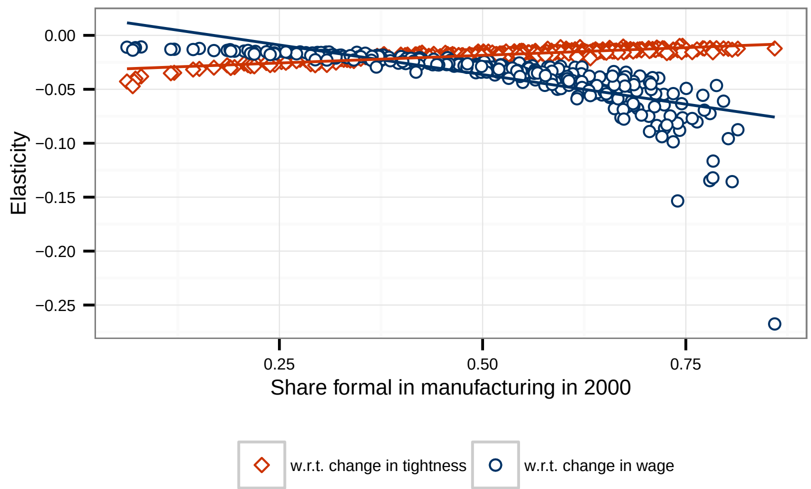
Source: RAIS Brazilian Ministry of Labor.
Exposure to minimum wage increase is measured as the share of workforce in the past year which does not meet this year minimum wage requirements.

Figure 8. Goodness of fit, by size percentile.



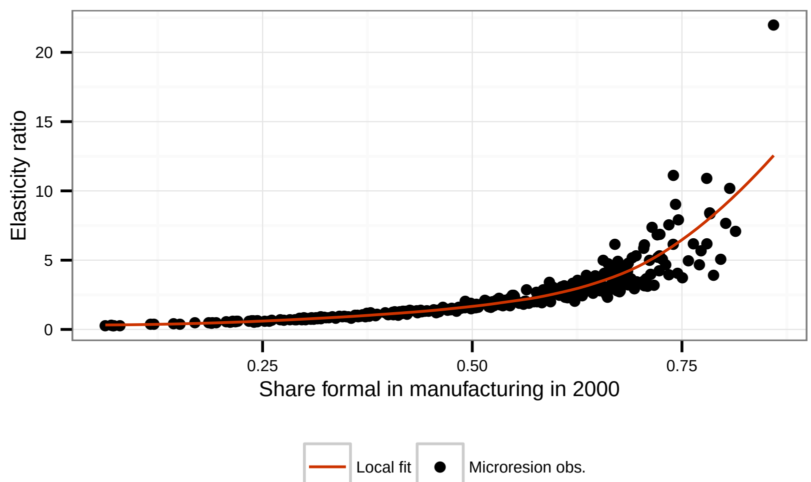
Model fit based on GMM estimates, moments weighted with lagged firm size. Sample: RAIS, manufacturing firms 1 year and older with 5 and more workers active in microregions with more than 20 manufacturing firms, 1997-2010.

Figure 9. Estimated elasticities at a firm which pays median wages in each microregion, plotted against share of formal sector sector in manufacturing in 2000.



Each point represents a microregion. Estimates based on GMM estimation. Sample: RAIS, 331 microregions with more than 20 manufacturing firms, 1997-2010.

Figure 10. Ratio of elasticity with respect to change in wages to elasticity with respect to change in labor market tightness. Elasticities at a firm which pays median wages in each microregion plotted.

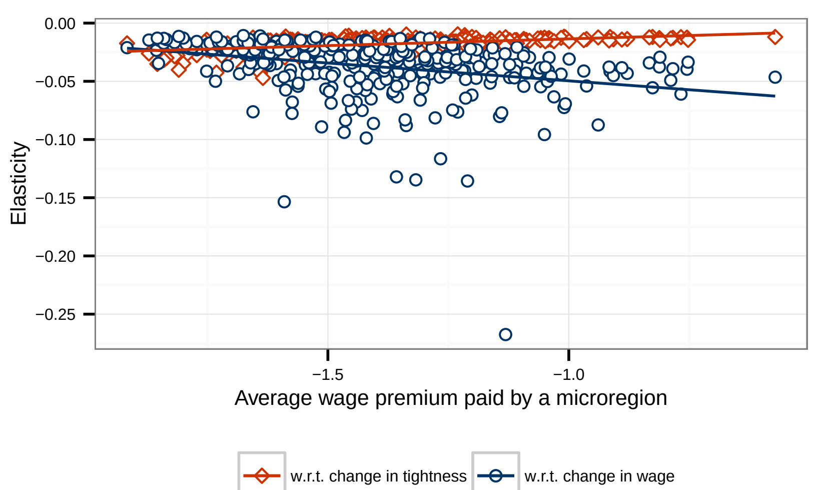


Each point represents a microregion. Estimates based on GMM estimation. Sample: RAIS, 331 microregions with more than 20 manufacturing firms, 1997-2010.

Figure 11. Estimated elasticities at a firm which pays median wages in each microregion, plotted against the average wage premium paid by each microregion.

Each point represents a microregion. Estimates based on GMM estimation. Sample: RAIS, 331 microregions with more than 20 manufacturing firms, 1997-2010.

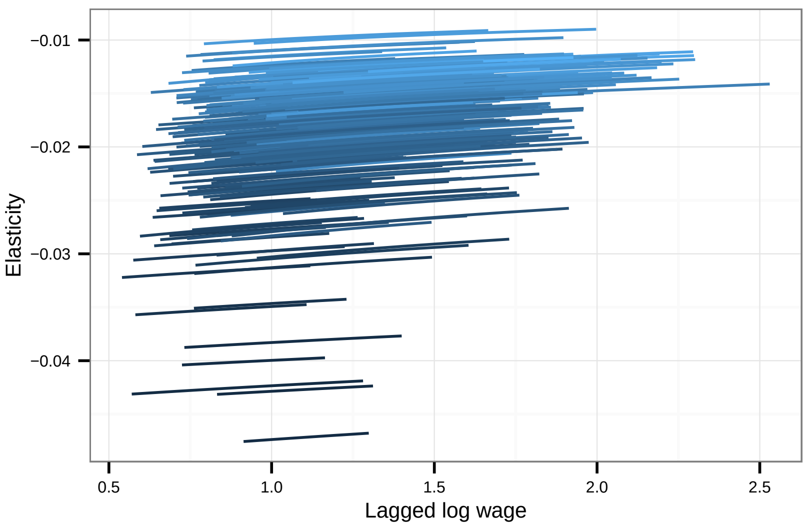
Figure 12. Estimated elasticities at a firm which pays median wages in each microregion, plotted against the logarithm of total employment to population ratio in 2000.



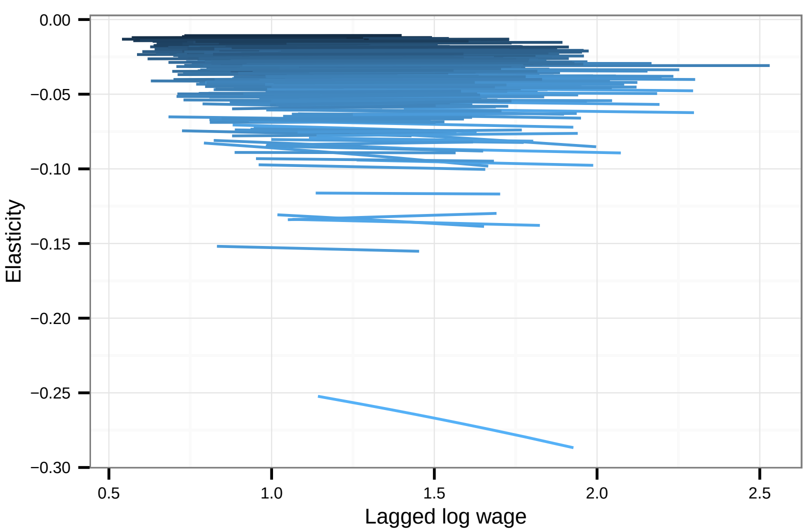
Each point represents a microregion. Estimates based on GMM estimation. Sample: RAIS, 331 microregions with more than 20 manufacturing firms, 1997-2010.

Figure 13. Estimated elasticities as a function of wages. Each line representa a microregion.

(a) Elasticity with respect to change in labor market tightness.

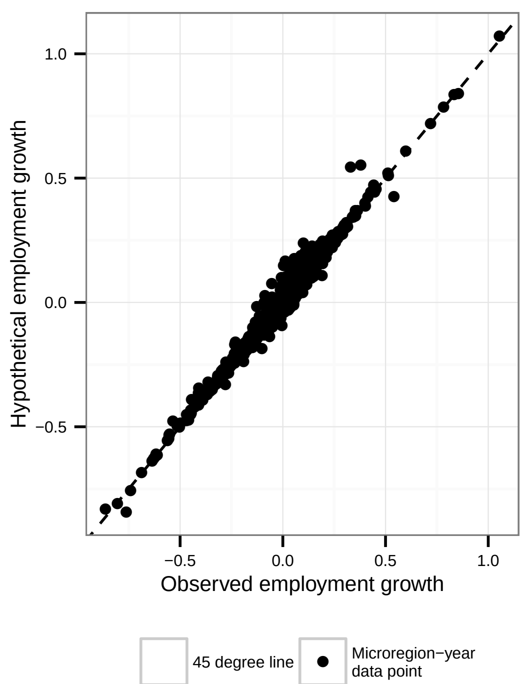


(b) Elasticity with respect to change in wage.



Each line represents a microregion and plots elasticities for the firms from 10th to 90th percentile of wages within a microregion. Estimates based on GMM estimation. Sample: RAIS, 331 microregions with more than 20 manufacturing firms, 1997-2010.

Figure 14. Hypothetical employment growth if labor demand elasticities were the same across microregions.



Each point represents a microregion-year data point. Estimates based on GMM estimation. Sample: RAIS, 331 microregions with more than 20 manufacturing firms, 1997-2010.

A Data appendix

Table 21. Coefficients of the regression of the logarithm of real hourly wages on workers characteristics (specification (2.5)), 1996-2002.

Variable	Dependent variable: Log hourly real wage						
	1996	1997	1998	1999	2000	2001	2002
Intercept	1.8	1.8	1.8	1.7	1.7	1.6	1.6
Age−35	0.011	0.012	0.012	0.012	0.012	0.012	0.012
$(\text{Age}-35)^2/100$	−0.071	−0.07	−0.069	−0.067	−0.066	−0.062	−0.061
Tenure	0.032	0.032	0.031	0.031	0.032	0.031	0.031
Female	−0.31	−0.3	−0.29	−0.28	−0.28	−0.27	−0.27
Illiterate	−0.48	−0.48	−0.45	−0.44	−0.41	−0.41	−0.39
4th gr incomplete	−0.41	−0.42	−0.4	−0.38	−0.36	−0.35	−0.33
4th gr complete	−0.36	−0.36	−0.35	−0.32	−0.31	−0.29	−0.27
8th gr complete	−0.29	−0.31	−0.3	−0.27	−0.26	−0.24	−0.23
8th gr incomplete	−0.24	−0.26	−0.25	−0.23	−0.22	−0.2	−0.19
HS incomplete	−0.18	−0.19	−0.18	−0.17	−0.16	−0.15	−0.13
Col incomplete	0.27	0.28	0.3	0.31	0.33	0.34	0.34
Col complete	0.55	0.59	0.63	0.65	0.68	0.71	0.71
Professionals	0.4	0.36	0.37	0.37	0.38	0.38	0.37
Senior managers	0.83	0.78	0.78	0.78	0.76	0.79	0.77
Administration	0.11	0.081	0.08	0.082	0.081	0.079	0.073
Sales	0.18	0.15	0.14	0.15	0.14	0.13	0.12
Services	−0.12	−0.12	−0.13	−0.14	−0.13	−0.14	−0.14
Agriculture	−0.38	−0.35	−0.32	−0.29	−0.29	−0.26	−0.26
Production							
MMC CNAE 3 dig FE	X	X	X	X	X	X	X
Obs	4,847,008	4,796,784	4,606,717	4,760,201	4,986,030	5,185,366	5,426,707
R^2	0.69	0.71	0.7	0.7	0.7	0.7	0.7

Sample: all workers employed in manufacturing in December of each year (RAIS). All coefficients are significant at 1% level using robust s.e. Omitted education group: high school graduates. Omitted occupation group: production workers. “gr” stands for grade, “HS” stands for high school, “Col” stands for college.

Table 22. Coefficients of the regression of the logarithm of real hourly wages on workers characteristics (specification (2.5)), 2003-2010.

Variable	Depenedent variable: Log hourly real wage							
	2003	2004	2005	2006	2007	2008	2009	2010
Intercept	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.7
Age−35	0.012	0.012	0.012	0.011	0.011	0.011	0.011	0.01
$(\text{Age}-35)^2/100$	−0.057	−0.054	−0.051	−0.048	−0.047	−0.046	−0.045	−0.043
Tenure	0.03	0.031	0.03	0.029	0.029	0.028	0.027	0.027
Female	−0.26	−0.25	−0.25	−0.24	−0.24	−0.25	−0.24	−0.24
Illiterate	−0.42	−0.4	−0.39	−0.37	−0.35	−0.34	−0.32	−0.31
4th gr incomplete	−0.32	−0.3	−0.29	−0.27	−0.26	−0.25	−0.23	−0.22
4th gr complete	−0.25	−0.24	−0.23	−0.22	−0.21	−0.2	−0.19	−0.18
8th gr complete	−0.21	−0.2	−0.19	−0.18	−0.17	−0.16	−0.15	−0.14
8th gr incomplete	−0.17	−0.16	−0.15	−0.14	−0.13	−0.12	−0.11	−0.1
HS incomplete	−0.13	−0.12	−0.11	−0.1	−0.096	−0.095	−0.086	−0.077
Col incomplete	0.33	0.33	0.32	0.31	0.31	0.31	0.29	0.28
Col complete	0.71	0.72	0.72	0.72	0.71	0.71	0.69	0.67
Professionals	0.27	0.29	0.29	0.3	0.3	0.3	0.3	0.31
Senior managers	0.65	0.65	0.65	0.64	0.65	0.65	0.64	0.65
Administration	0.045	0.038	0.038	0.031	0.034	0.028	0.022	0.0073
Sales	0.092	0.096	0.083	0.088	0.089	0.08	0.08	0.14
Services	−0.15	−0.15	−0.15	−0.15	−0.14	−0.15	−0.15	−0.14
Agriculture	−0.25	−0.24	−0.26	−0.23	−0.23	−0.22	−0.22	−0.2
Production								
MMC CNAE 3 dig FE	X	X	X	X	X	X	X	X
Obs	5,558,567	6,114,527	6,269,290	6,531,935	6,964,608	7,160,447	7,154,166	7,283,427
R^2	0.7	0.7	0.7	0.69	0.68	0.68	0.68	0.67

Sample: all workers employed in manufacturing in December of each year (RAIS). All coefficients are significant at 1% level using robust s.e. Omitted education group: high school graduates. Omitted occupation group: production workers. "gr" stands for grade, "HS" stands for high school, "Col" stands for college.

B Estimates of the structural parameters

Table 23. Estimates of the parameters of the model: main parameters.

	$1/a_{0,l}$	$a_{1,l}$	$a_{2,l}$	$\beta_{1,l}$	$\beta_{2,l}$
Intercept	15.566	1.16	2.905	3.372	2.717
Log employment to population ratio	-0.574	-0.716	-0.252	-11.177	0.055
Share formal in mfg	1.431	0.951	1.107	1.807	0.062
Average wage premium		-1.719		-0.229	
Log employment to population ratio×Share formal in mfg	-1.677	-0.55	-1.42	1.44	0.059
Log employment to population ratio×Wage premium		0.844		-0.458	
Share formal in mfg×Wage premium		-1.12		0.303	

GMM estimation, weighted with the lagged firm size. Sample: all firms in manufacturing 1 year and older with at least 5 employees, active in microregions with more than 20 firms. 1997-2010. Log employment to population ratio, share of the formal sector in manufacturing and average wage premium have been divided by their standard deviations.

Table 24. Estimates of the parameters of the model: incidental parameters associated with exit.

	Intercept	Log employment to population ratio	Share formal in mfg
$\gamma_{1,l}$			
	0.055	0.11	-0.322
$\gamma_{2,l}$			
	-0.183	-0.092	-0.04
$\gamma_{0,lt}$			
1997	-1.691	-0.166	0.171
1998	-3.026	-0.099	0.242
1999	-3.27	-0.079	0.106
2000	-2.383	-0.015	0.127
2001	-2.237	-0.135	0.189
2002	-1.798	-0.181	0.241
2003	-2.93	-0.087	0.179
2004	-1.177	-0.111	0.079
2005	-2.27	-0.104	0.207
2006	-1.694	0.07	0.169
2007	-1.387	-0.037	0.022
2008	-2.037	-0.006	0.186
2009	-2.04	0.044	0.017
2010	-1.926	0.086	0.032

GMM estimation, weighted with the lagged firm size. Sample: all firms in manufacturing 1 year and older with at least 5 employees, active in microregions with more than 20 firms. 1997-2010. Log employment to population ratio, share of the formal sector in manufacturing and average wage premium have been divided by their standard deviations.

Table 25. Estimates of the parameters of the model: incidental parameters associated with control variable.

	Intercept	Log employment to population ratio	Share formal mfg
$\lambda_{1,l}$			
	0.556	0.168	0.154
$\lambda_{0,lt}$			
1997	−0.102	0.074	−0.053
1998	−0.113	−0.057	0.083
1999	−0.081	−0.094	0.217
2000	0	−0.287	0.225
2001	−0.075	−0.033	0.119
2002	−0.032	−0.081	0.141
2003	−0.211	0.016	0.064
2004	−0.069	−0.006	0.041
2005	−0.006	−0.202	0.026
2006	−0.123	0.221	−0.317
2007	0.1	−0.502	0.306
2008	0.013	−0.717	0.659
2009	−0.065	−0.402	0.158
2010	0.14	−0.949	0.374

GMM estimation, weighted with the lagged firm size. Sample: all firms in manufacturing 1 year and older with at least 5 employees, active in microregions with more than 20 firms. 1997-2010. Log employment to population ratio, share of the formal sector in manufacturing and average wage premium have been divided by their standard deviations.

Table 26. Estimates of the parameters of the model: controls

	Γ
Lagged age 0	-0.077
Lagged age 1	-0.107
Lagged age 2	-0.11
Lagged age 3	-0.109
Lagged age 4	-0.102
Lagged age 5	-0.098
Lagged age 6	-0.08
Lagged age 7	-0.085
Lagged age 8	-0.071
Lagged age 9	-0.072
Lagged muliest. status	-0.049

GMM estimation, weighted with the square root of lagged firm size. Sample: all firms in manufacturing 1 year and older with at least 5 employees, active in microregions with more than 20 firms. 1997-2010.

	$\mu_{0,t}$	$\mu_{1,t}$
1997	0.144	-0.048
1998	0.008	-0.011
1999	-0.012	0.009
2000	-0.066	0.045
2001	-0.005	0.001
2002	0.166	-0.026
2003	0.21	-0.045
2004	0.278	-0.045
2005	0.154	-0.016
2006	0.406	-0.111
2007	0.03	0.051
2008	-0.286	0.14
2009	-0.01	0.031
2010	-0.289	0.152

GMM estimation, weighted with the square root of lagged firm size. Sample: all firms in manufacturing 1 year and older with at least 5 employees, active in microregions with more than 20 firms. 1997-2010.